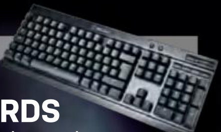

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Tuan
Nguyen

2016 IS WHEN THINGS START TO CHANGE

WHEN WE TALK ABOUT CHANGE, it can go one of two ways: there's evolutionary change and there's revolutionary change. For the past three years or so, there's been a number of significant evolutionary changes, leading up to what we're about to see in 2016.

SSDs hit a performance ceiling, making way for a new generation of drives based on the new NVMe standard, running over PCI Express. Windows 10 brought with it DX12, which is supposed to usher in multi-GPU adapters, enabling you to pair up GPUs from different vendors and get aggregated performance boosts. Both Microsoft and Oculus are getting hugely serious with the next generation of media—AR and VR, respectively.

The sea changes will arrive when AR and VR hit mainstream status. To get there, both companies know there's much to be done. There's still a lot to do on the hardware side, but the enormous work will be in the hands of developers, who also need to figure out how to effectively develop for the new platforms. Then there's the hardware ecosystem that will be the backbone of it all coming together and actually working. AMD and Nvidia have their work cut out if we're going to have a serious push into realism. And that's really what it's always been about: How soon can we get to an experience that can make us truly believe we're somewhere else?

My prediction: Both the CPU and GPU are going to get significantly faster this year—more than ever. This is due to both external needs as well as, with the legacy storage system becoming ultra fast, more data can be fed at much higher rates. I'm super excited about what's to come this year, and we'll give you an insider's look in the pages of this issue.

Despite everything moving forward, there is one aspect of my computing experience that has actually moved backward in time: my keyboard. Several years ago, the direction for keyboards was that of thinner, quieter, sleeker. Now, all my fellow enthusiast friends and serious typists are back on technology invented in the 1900s. In this issue, we're going to take a look at the latest keyboards and see their nuances in terms of finger-pleasure-inducing features.

There's an ocean of keyboards on the market, and with them a buffet of switches. There's the annoy-the-hell-out-of-coworkers Cherry MX Blue switches—which are my favorites—and Browns, Reds, Blacks, etc. And now there are other switches that compete with Cherry, too, made by Logitech and Razer for their own exclusive products.

I've always recommended that my friends invest in the display and the keyboard, because that's where your body interacts most with the PC. I love typing on a mechanical keyboard, and would never go back to the membrane variety. Whether for work or gaming, it's got to deliver that clickety-clack for me.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Should Chrome OS & Android be Merged?

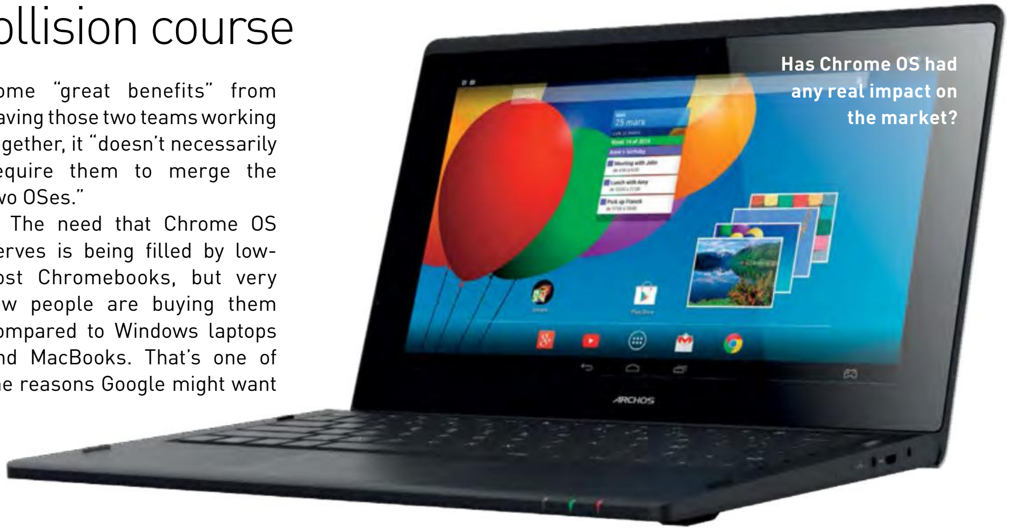
Two OSes on a collision course

IN ANDROID, Google owns the most popular mobile operating system on the planet. In contrast, Chrome OS holds a very small share of the PC market. On the surface, it seems to make sense for Google to combine the two OSes into a unified platform, and it was reported by the *Wall Street Journal* that plans to do exactly that have been in motion for the past two years—but would it really be a good idea?

Although it's early, the unified OS strategy is working for Microsoft with Windows 10. Nevertheless, the consensus from several analysts we reached out to is that Google should keep Android and Chrome OS separate.

Christian Kane, an analyst at Forrester, told *Maximum PC* that Google is better off taking the same approach as Apple, which is "connecting the dots between the two OSes where it makes sense," such as cross notifications and access to cloud storage. In general, he sees Chrome OS and Android "filling very different needs," and though there might be some "great benefits" from having those two teams working together, it "doesn't necessarily require them to merge the two OSes."

The need that Chrome OS serves is being filled by low-cost Chromebooks, but very few people are buying them compared to Windows laptops and MacBooks. That's one of the reasons Google might want to consider folding Chrome OS into a platform as popular as Android. But doing so might not change things.



Has Chrome OS had any real impact on the market?

"I think it's just much more difficult to disrupt the PC market than it is to disrupt mobile," Vincent Vizzaccaro, executive VP of Marketing and Strategic Relationships at Net Applications, told *Maximum PC*. "Apple's been offering PC alternatives for decades, and they still only have 8 percent of desktop usage market share. But, when the first iPhone came out, they completely disrupted that market. Would Android on the desktop make an impact for Google? I don't think so. I believe the person who would want Android on a desktop would be just as satisfied with Android on a tablet… probably more so."

Along those same lines, William Stofega, program director of Mobile Device Technology and Trends for IDC, told us "it makes no sense for Google to shut down Chrome OS" after it's been trying so hard to break into the PC market with Chromebooks and is "now starting to gain traction." The Chrome OS market share might be small, but "the education market is pretty big," Stofega added.

David Smith, a VP at Gartner Research, went against the grain and offered a different take. "It makes sense for Google to have a unified offering, and it makes more sense to fold limited Chrome OS capabilities into the much more prevalent Android OS, which has over a million apps available," Smith told *Maximum PC*.

We also reached out to Acer and Asus for their thoughts, as both have a vested interest in Android and Chrome OS, but neither was willing to comment. In the end, it may not matter what anyone thinks because Google, at least for now, is keen to keep the OSes separate.

"While we've been working on ways to bring together the best of both operating systems, there's no plan to phase out Chrome OS," Google stated in a blog post. **–PL**

> “ On the surface, it makes sense to combine the two OSes into a unified platform

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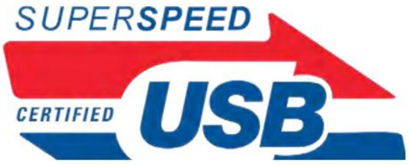

Look for the USB-IF certification logo when shopping for cables.

GOOGLE ENGINEER CALLS OUT CRAPPY CABLE MAKERS

Buyer beware

NOT ALL CABLES are created equal. You might already know that, but to drive the point home, an engineer at Google decided to leave user reviews on Amazon for a variety of USB Type-C cables.

Benson Leung has a vested interest in weeding out crappy Type-C cables. He helped create two Pixel products that use the Type-C connector and take advantage of its related technologies, such as Power Delivery, Alternate Mode, and USB 3.1.

"It really is an amazing little connector," Leung says. "However, now that there are more and more Type-C products rolling out from Nexus, One Plus, Nokia, and more, this I have found painfully true: USB Type-C will only be as good as its ecosystem, and more specifically, the worst of its ecosystem."

Leung said he decided to review USB cables on Amazon because he's "fed up with the early cables from third-party vendors that so blatantly flaunt the specification," and he wants to "hold them to task."

More than just annoyance, Leung says a poorly made cable doesn't just result in "weird behavior," it's actually "downright dangerous" to use. He notes this in some of his reviews, including a CableCreation USB 3.1 Type-C (USB-C) to Standard Micro USB B Female Adapter, which he states "may cause damage to your USB charger, PC, or hub."

Of that cable, he says it doesn't follow the USB Type-C specification for power delivery identification, because it advertises itself as 3A capable, "but that is not appropriate because this is a legacy host port adapter."

Some symptoms he noted in his reviews are less harmful, though, like not being able to charge the Chromebook Pixel.

It's not all bad news (and reviews)—some cables pass muster and earned a five-star rating from Leung, including iOrange-E's 6.6-foot braided Type-C cable. That one exceeded his expectations, he says. **–PL**

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MAGICSTICK CAPTURED THE ATTENTION of crowdfunders on Indiegogo, where it blew past its goal of raising $50,000. It's similar to Intel's ComputeStick, but more powerful, packing up to 8GB of RAM, and an Intel quad-core Cherry Trail processor.

The MagicStick will come in two flavors: the $199 One unit and the meatier $399 Wave unit. Both provide a microSD card slot for up to 128GB of extra storage, Wireless-N connectivity (up to 300Mb/s), a USB 3.0 Type-C port, and two USB 2.0 ports. The device connects to an HDTV or monitor via a built-in HDMI 2.0 jack. A list of common features shows that both models also include Bluetooth 4.1 connectivity, support for Wireless display, hardware-accelerated identity protection, and 4K Ultra HD hardware encoding. They also sport a three-month trial of Windows 10, as well as Android 5.0 Lollipop. **–KP**

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SanDisk

WESTERN DIGITAL has agreed to purchase SanDisk for around $19 billion in cash and stock. The move will help secure Western Digital's future, as the PC industry shifts away from mechanical disks and toward faster flash-based storage solutions.

"With this transaction, Western Digital will double its addressable market and expand its participation in higher-growth segments," Western Digital said in its announcement. "SanDisk brings a 27-year history of innovation and expertise in non-volatile memory, systems solutions, and manufacturing. The combination also enables Western Digital to vertically integrate into NAND, securing long-term access to solid-state technology at lower cost." Western Digital indicated that the deal will pull together more than 15,000 patents of both companies, and will produce a "broader set of products and technologies," ranging from HDDs to SSDs, to flash storage products to cloud data center storage products. **–PL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

FIXING A BROKEN BAT

+ *Batman: Arkham Knight* re-launched to PC in polished form after Warner Brothers pulled the game due to performance issues.

BOLD ACQUISITION

+ Michael Dell orchestrated the largest tech deal ever—to buy cloud and data storage outfit EMC for $67 billion.

CATALYST TO RETIRE

+ AMD is replacing its Catalyst Control Center with Radeon Software Crimson, a faster interface that will deliver more frequent driver updates.

TRAGEDIES

STINGY WITH STORAGE

– Microsoft is dropping unlimited OneDrive storage for Office 365 subscribers. Why? Because some people *GASP* uploaded a lot of files.

PUNISHING HONEST GAMERS

– Bethesda could have put *Fallout 4* in its entirety on discs for PC, but chose to require an additional Steam download to fight piracy.

THE WAITING GAME

– Extensions support for Microsoft's Edge browser in Win 10 has been delayed until some time in 2016.

Tom Halfhill

FAST FORWARD

It's Not Your Computer Anymore

WHO OWNS YOUR COMPUTER? The question seems to have an obvious answer, rather like "Who's buried in Grant's tomb?" If you bought your computer, of course it's yours. However, Windows 10 brings us to a crucial crossroads....

You see, Windows 10 gives Microsoft unprecedented control over our computers. Although it's not our first step on this road, we're now passing the point of no return.

I'm talking about mandatory system updates, a controversial feature of Windows 10. Unless you're running the Enterprise edition, Windows 10 automatically downloads and installs system updates every "Patch Tuesday," or more often. Unlike with previous versions of Windows, you can't stop it. So I'm shunning Windows 10, even though it's free and I can barely tolerate Windows 8.1.

A recent snafu explains why. On a Patch Tuesday that listed more than 20 system updates, I noticed a new device driver for my WLAN adapter. (I always configure my PCs to let me check and install system updates manually.) The wise editors of this magazine generally recommend installing the latest drivers to fix bugs and improve performance, and that advice is generally good. But I'm wary of things that tinker with my hardware. So I noted the update's filename before approving the installation.

Disaster! My Wi-Fi connection slowed to a crawl. Downloading just a few emails took hours. It was worse than the Stone Age when we used 300-baud acoustic-coupled modems over analog phone lines. Rebooting my computer didn't help either. Luckily, I knew which of those 20-plus system updates to uninstall first. Rolling back to the old WLAN driver fixed the problem.

But what if I had Windows 10? It would have installed the wonky update automatically. Suddenly, my PC would be a snail, and I wouldn't know why. It might take hours of cunning detective work to figure out which update was to blame. And then what? After I nuked it, Windows 10 would install it again. I could try hiding the update from the installer, but even Windows 8.1 sometimes unhides a hidden update. And imagine trying to diagnose this problem on a newbie's PC.

For Microsoft, controlling our computers is a cost-benefit equation. Millions of people turn off automatic updates and never install them manually, exposing their PCs to unpatched bugs and security holes. Microsoft calculates that more people will benefit from mandatory updates than will be harmed by wonky updates. The calculation is probably accurate, but a better solution would be to enable automatic updates by default and require a little expertise to turn them off.

I don't oppose all automatic updates. I don't mind them on my Chromebook, iPad, or Tivo, because those are closed platforms whose hardware is strictly limited, so there's less to go wrong. Macs have more variation but are still constrained. Windows PCs, by contrast, are wide-open platforms with an almost infinite variety of hardware and software components. Unforeseen interactions are commonplace and can be difficult to diagnose.

For years, Microsoft has struggled to make PCs easier to maintain. It's a laudable goal, and much progress has been made. (Remember when hardware upgrades required users to reconfigure the system interrupts?) By making system updates compulsory, Windows 10 is simply taking the next step. But it's a crucial step that stumbles over the platform's complexity while alienating expert users. For me, it's a step too far.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

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Alex Campbell

OPEN SOURCE

What I Learned from Science Hack Day

WHAT HAPPENS when you get a bunch of geeks together and let them play for 36 hours? You get Science Hack Day, an annual event focused on STEM-based fun and learning.

When I first learned about Science Hack Day in October, I was intrigued: Dedicate a weekend to playing with circuits, code, and other bits of sciencey shenanigans? Sounds great. Sign me up!

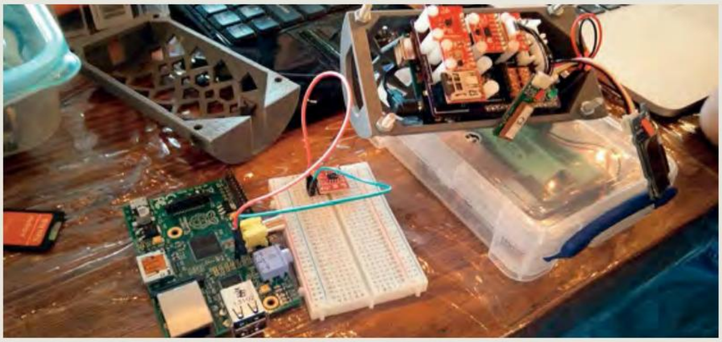
Science Hack Day started in 2010, with simultaneous events in San Francisco and London. Since then, the event has grown to 30 cities spread over 19 countries. Hack Days occur on different dates, depending on the city. The event that I attended was on October 24, and was hosted at GitHub's headquarters in San Francisco.

When the time came for people to present their proposals, I was impressed with how many ideas were shared. During the presentations, so many of them sounded so cool that it was hard to decide what team to join, and there was no shortage of options.

Projects included an "electronic jungle" of Arduino-powered noisemakers, a game where the input device was a banana, and a computer-aided pool table that would help plan shots by projecting the cue ball path on to the table with a laser. One project created a website and social media campaign for Saturn Day 2016. (See it at SaturnDay.org.)

I quickly learned that lots of talented people are willing to give their spare time to solve problems, whether real or artificial. Of course, I already knew this intellectually, since free and open-source software would not exist without people like that. But it's a different experience to see people do it in person. Unless you're the type to attend developer conferences or hang out in IRC channels on a regular basis, most free and open-source development processes are nearly invisible. It's a real joy to see people excitedly show off the projects they're working on.

> It was fun to step back and think about how all the participants came to just play and experiment.



I learned a lot trying to get this RPi to talk to the Arduino in the "CanSat."

When you spend time working on a particular problem, it's amazing what you learn along the way. (For me, that learning moment came when I needed to get a Raspberry Pi to talk to an Arduino board over USB in Python.) Technical skills weren't the only things to be learned: Project management, communication, originality, and prototyping skills were all present in the "winning" hacks. That's not so different from open-source projects.

Sure, when you think of open-source contributors, you think of coders and software engineers. But successful software projects need more than that. They need writers to produce documentation and web page content. They need translators who can make sure that the software is accessible to people in different countries. Artists are needed for logos and branding. Everyone has something they can offer, even if it's a humble bug report.

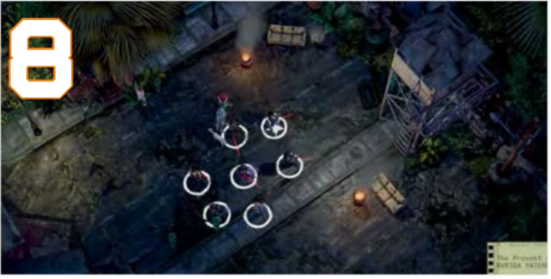
When I wasn't staring at a screen reading Python documentation, it was fun to step back and think about how all the participants came to just play and experiment with hardware, code, and science to create something. Nobody was getting paid, and there were no material prizes, save for a few medals.

But this was just 36 hours. We all know the real world doesn't work this way. People have to work a day job to pay bills and generally be adults. Most people don't make their money by giving ideas away for free. That said, there's something to be said for allowing your creative side some true freedom from time to time.

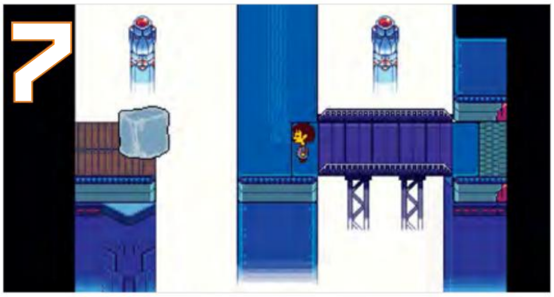
Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

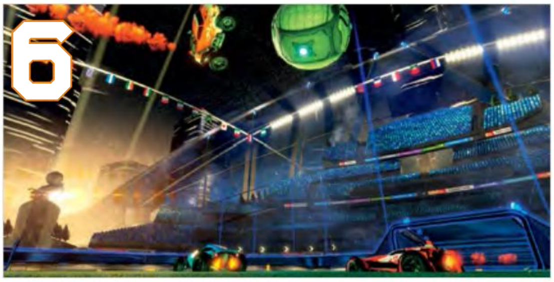
EIGHT GAMES WE LOVED IN 2015



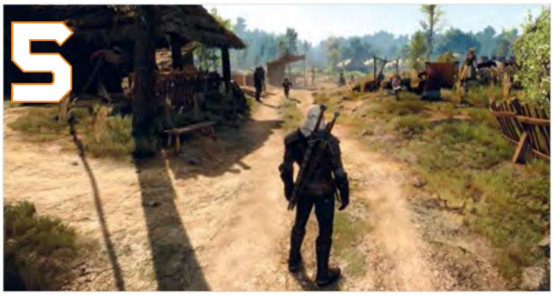
WASTELAND 2: DIRECTOR'S CUT *October 15*: The anniversary update to last year's Kickstarter.



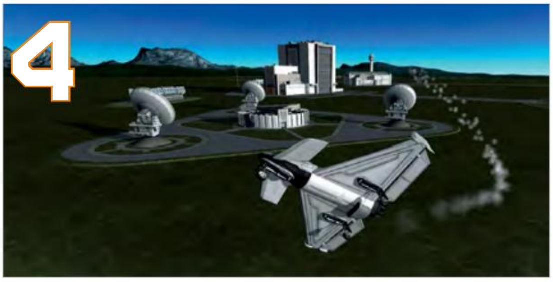
UNDERTALE *September 15*: Indie JRPG of peace or genocide—you decide!



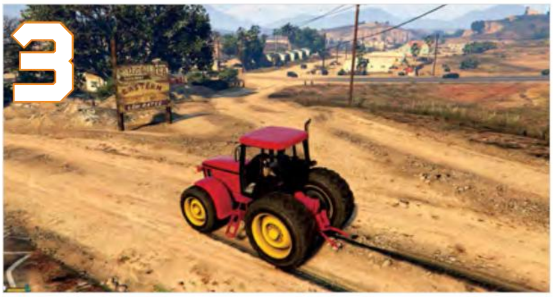
ROCKET LEAGUE *July 7*: Rocket-powered cars playing soccer, only much better than it sounds.



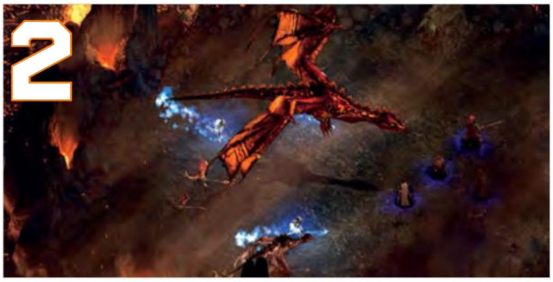
THE WITCHER 3 *May 19*: A massive RPG full of action, powerful stories, and political treachery.



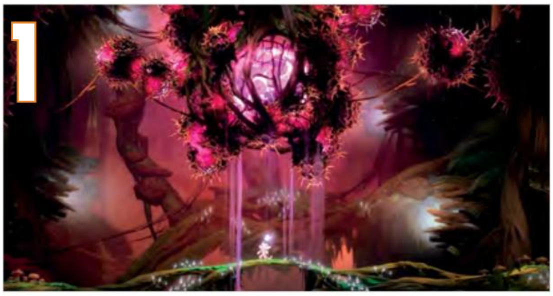
KERBAL SPACE PROGRAM *April 27*: The quirky sandbox space sim eventually left early access.



GRAND THEFT AUTO V *April 14*: It finally made its way to the definitive gaming platform.



PILLARS OF ETERNITY *March 26*: This RPG was Kickstarted by fans of the old Black Isle games.



ORI AND THE BLIND FOREST *March 11*: A challenging and beautiful modern take on platformers.

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HEAD TO

BY **PAUL LILLY**

Nexus 5X vs. Nexus 6P

Although there are tons of Android phones, Google's Nexus line exemplifies the company's vision for what a stock Android phone should be. This year, Google has graced us with not one Nexus, but two: the Nexus 5X, the true successor to the original 2013 LG-made Nexus 5, and the larger Nexus 6P, made by first-time Nexus manufacturer, Huawei. While they are made by different companies, they share a number of similarities. Both ship with Android 6.0, code-named Marshmallow, both offer a new fingerprint scanner, and more. But there are some distinct differences, too. Which device is for you? We pitted the 5X against the 6P to help you figure it out.

Both the Nexus 5X, seen here, and the Nexus 6P offer various color options to choose from.

ROUND 1

Design

At 5.2 inches, the Nexus 5X's display is a little bigger than the 4.9-incher of the original Nexus 5. If you've got large hands, you could probably single-hand it for most applications. It helps that the device is still pretty light at 136 grams. Moving to the Nexus 6P, it isn't as big as last year's Nexus 6, but at 5.7 inches, it's too large to use with one hand. Luckily, it's very thin at 7.3mm, making it thinner than the 7.9mm Nexus 5X.

Both feature a fingerprint scanner on the back, which can be used to unlock the phone. The dual speakers at the top and bottom sound fantastic.

What sets the 6P apart is its build quality. Because we've never used anything from Huawei before, we were curious about how it would do with Google's top-end product, and found that the CNC-machined "aeronautical-grade" aluminum indeed feels more premium than the 5X's more plastic body.

Winner:
Nexus 6P

ROUND 2

Display

The Nexus 5X's 5.2-inch display uses a 1920x1080 resolution panel, which is the same resolution as the previous Nexus 5. Even with the slightly bigger screen compared to the 2013 model, the pixels-per-inch are still quite high, though, at 423ppi.

LG also employs Gorilla Glass 3 to protect the screen from scratches, and there's a smudge-resistant coating as well—although we were still able to see a small amount of smudging on our phone. While the screen looks nice enough, whites appear a little more tan than they should.

We have absolutely nothing negative to say about the 6P's larger 5.7-inch screen, however. With its 2560x1440-resolution AMOLED display, it's got a super high pixels-per-inch of 518ppi. It also uses Gorilla Glass 4, as opposed to the 5X's GG3 equivalent. Colors here looked vibrant and accurate. Because of this, it's very easy to give the nod to the 6P.

Winner:
Nexus 6P

HEAD

nexus
HUAWEI
nexus
HUAWEI
nexus
HUAWEI

The "P" in 6P stands for "premium" in Google's high-end phone.

ROUND 3

Specifications

Nexus phones have never used the fastest components, and that's still true, but the tech specs are more than good enough. The Nexus 5X features a 64-bit 1.8GHz hexacore Snapdragon 808 processor, 2GB of low-power DDR3 RAM, and an Adreno 418 GPU. In terms of storage, SKUs come in 16 and 32GB varieties.

With a sharper screen, the Nexus 6P needs a beefier SOC, so Huawei packed it with a 2GHz octa-core Qualcomm Snapdragon 810 v2.1 processor and 3GB of LPDDR4 RAM. For graphics, it uses an Adreno 430 GPU. It has the same Bluetooth and NFC bells and whistles that its sibling supports. As it has beefier components, it beat the 5X in our benchmarks (Antutu, Geekbench 3, 3DMark, and Passmark) by 14–59 percent!

Still, don't let the numbers fool you. Both phones were buttery smooth and snappy in our real-world tests.

Winner:
Nexus 6P

ROUND 4

Battery Life

Battery life was the weakest aspect of the original Nexus 5 with its 2,300mAh brick, so LG has thrown in a bigger 2,700mAh model. The Nexus 5X improves upon its predecessor, but it's still not the longest-lasting phone. Google says you should be able to get nine hours of Wi-Fi out of the device, and our actual use scenario was very close. Through heavy real-world usage—watching videos, running benchmarks, surfing the web, using apps—we were able to go for eight hours and 45 minutes before it keeled over.

Because the 6P has the bigger chassis, it's able to squeeze in a huge 3,450mAh battery. As a result, we got a noticeable longevity boost over the 5X, with our phone lasting roughly 12 hours and 45 minutes in our real-world tests.

Even though the 6P's bigger screen soaks up battery at a faster clip than the 5X's, its bigger battery makes up for it in brute strength.

Winner:
Nexus 6P

ROUND 5

Camera

Another area where Nexus phones are often criticized is the camera department. Sadly, neither the 5X nor the 6P have optical image stabilization. This might not matter much for still photos, but if you try to shoot video as you're walking, you'll notice how shaky it looks.

If you can ignore that, both cameras are fantastic, and use the same innards. Both phones use a 12.3-megapixel sensor from Sony, and feature an f/2.0 aperture. Word on the street is that the sensor was originally meant for a discrete camera and not a phone. Both cameras can shoot 4K video at 30fps, and slow-motion video at 120fps. Compared to the original Nexus 5's camera, both the 5X and 6P produce much more vibrant and accurate colors. Both also work better in low light, though there is still some noise at night.

Because both phones effectively use the same excellent camera, this category ends in a tie.

Winner:
Tie

And the Winner Is...

Which phone should you get? Honestly, you can't go wrong with either, because they're both excellent devices, and Google promises at least 18 months of updates on each one. If you're a little strapped for cash, and want something you can use with one hand, the Nexus 5X (which starts at $380 for the 16GB model) is a good choice. If you don't mind the larger size and ponying up the extra cash for the Nexus 6P (which starts at $500 for the 32GB model), the 6P is the obvious choice. As for this competition, however, we're giving the **Nexus 6P** the win because it does everything the Nexus 5X does but slightly better.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> SLI Decisions
> Temperature Tips
> Graphics Dilemmas

To SLI or Not to SLI

I have a Gigabyte GA-990FXA-UD5 motherboard with an AMD FX-8320 processer, 32GB of Corsair DDR3-1600 memory, and two MSI GTX 960 OC graphics cards. My question is whether the two 960s (with 2GB of GDDR5 each) are better or worse than a single GeForce GTX 970 or 980? I use my PC for programs like Excel, and I like to make greeting cards. I do play hidden object games from Big Fish, but they're not very demanding. I run a DisplayPort cable to my 27-inch Asus VX279 monitor. Let me know what you think. **—Ron V**

MSI's Z170A Gaming M5 is a solid example of Skylake with a twist, offering PCIe, room for M.2 drives, USB 3.1, and a hot color scheme.

THE DOCTOR RESPONDS: With all due respect, Ron, you should probably take one of those GeForce GTX 960 cards out of your PC to save power. It sounds like the tasks you run mostly include productivity and casual gaming, neither of which requires a $200 graphics card (much less two). But let's think about the question as if you were playing fast-paced shooters on a monitor with a native resolution of 1920x1080 or 2560x1440.

Combining the power of multiple GPUs through Nvidia's SLI technology (AMD's equivalent is called CrossFire) improves performance when bottlenecked by a fully-utilized GPU. But you need a demanding 3D application for that to be the case. What's more, the on-board memory of each card isn't additive—information stored on one exists on the other as well—so two 2GB cards yield an effective 2GB.

With that said, you can get away with 2GB of memory at 1920x1080. That's the native resolution of your Asus VX279. Two GTX 960s with 1024 CUDA per GPU might be a good match for the 2048-core GTX 980's performance, especially since the pair costs about $100 less. But for someone who already owns modern mainstream cards in SLI, no way the Doc would recommend a single GTX 980 as an upgrade.

Moving to 2560x1440 really calls for a card with 4GB of memory, though. You'd definitely see a speed-up going from one 2GB board to two at QHD. Ultimately, though, they would run out of memory and limit your frame rates.

Pick a New Platform

Which LGA 1150 motherboard is the best for gaming? My PC finally died and I need to build another one. Thanks! **—Christopher Prost**

THE DOCTOR RESPONDS: That's a difficult question to answer, Christopher, particularly without more background information. What the Doc can tell you, though, is that LGA 1150 might be the wrong interface to shop for. Intel recently launched its Z170 platform controller hub for LGA 1151-based CPUs built on the Skylake architecture. At the time of writing, there aren't many compatible processors available. The least expensive model costs just under $100, and if you want an overclockable chip, prepare to spend $270 on a Core i5-6600K.

Still, the Doc thinks that Z170 is worth its premium to PC enthusiasts. To begin, the chipset's connection to its host CPU, called DMI, is now based on PCI Express 3.0, nearly doubling its throughput. Instead of eight second-gen PCIe lanes originating from the PCH, Z170 offers up to 20 PCIe 3.0 lanes. And, for the first time, Intel's Rapid Storage Technology driver incorporates support for PCIe-based SSDs. That's all on top of its 10 USB 3.0 and six SATA 6Gb/s ports.

Z170-based motherboards go from $100 to $500, so the right one depends largely on your budget. But an emphasis on gaming should include

↘ submit your questions to: doctor@maximumpc.com multiple 16-lane PCI Express slots, room for DDR4 memory, and M.2 connectivity for the fastest PCIe-based SSDs.

New Lipstick?

After reading so much of what *Maximum PC* writes, I'm sure this is a question you get a lot. But here goes. The last time I upgraded, I used a "video card thermometer" that might have been published five years ago or so. Back then, my GPU ranked toward the bottom, compelling me to build my current system. It's a Core i7-2600K at 3.4 GHz, 8GB of DDR3-1600 memory, an Asus P8P67 motherboard, XFX's Radeon HD 5850 1GB, and a 650W power supply. A couple of years ago, I also added an SSD.

But after watching so many generations of newer hardware come and go, I'm wondering whether it's time to upgrade. Given that *Fallout 4* and *XCOM 2* are launching soon, should I start afresh or just replace a couple of components to put some lipstick on my aging pig? Sure would be nice to see another thermometer page, too.

—Bruce Brand

THE DOCTOR RESPONDS: The Doc isn't expecting *XCOM 2* to be particularly demanding. On the other hand, Bethesda's recommended specs for *Fallout 4* are downright high-end. If that's on your wish-list, then yes, it's time for an upgrade.

Let's start with the graphics card. *Fallout 4* calls for at least a Radeon HD 7870, which is two and a half years and two generations newer than your 5850. A Radeon R9 390 or GeForce GTX 970 would be a great step up for around $300.

Intel's Core i7-2600K was a fantastic CPU, and at 3.4GHz, it sounds as though your sample is still going strong. Frankly, you could get away with your existing platform *(Fallout 4's* minimum is a Core i5-2300). But the Doc likes to keep his system as balanced as possible. Skylake is the first architecture since Sandy Bridge that warrants an upgrade, so a Core i5-6600K or Core i7-6700K on a Z170-based motherboard would be a solid step up and quite complementary.

Get ready to drop some serious coin to see *Fallout 4* in all its glory. That's what the recommended specs suggest at any rate.

To that, add 16GB of DDR4 memory. So long as the SSD and 650W power supply are of high quality, they can carry over to your new build. From there, all that's left to do is enjoy the latest and greatest in gaming goodness. And you should be ready for the Oculus Rift launch in 2016, too.

Too Hot to Handle?

Doc, I just built my first rig with an Intel Core i7-4790K, Gigabyte Z97X-UD5H-BK, G.Skill Sniper DDR3-1866 kit, and GeForce GTX 970 card from MSI.

With Turbo Boost turned off in my BIOS, the processor's frequency is 4,000MHz, the ratio multiplier is 40x, the reported CPU Vcore is 1.080V, and the CPU temperature is 25 C. With Turbo Boost on, the clock rate is 4,400MHz, the ratio is 44x, I'm seeing a CPU Vcore of 1.260V, and the temp rises to 34 C.

Honestly, I'm not particularly computer savvy, and I am worried that with Turbo Boost enabled, the Vcore is too high. Moreover, with Turbo turned on, according to SpeedFan, I'm getting up to 68 C in HandBrake.

—Bryan

THE DOCTOR RESPONDS: The short answer is that you're seeing Turbo Boost function exactly the way it's meant to, Bryan. If you run an application that only utilizes one of the -4790K's four cores, the chip doesn't get particularly hot or use much of its power budget. So, Intel ramps up frequency (and voltage) as high as 4.4GHz to get through your workload faster, all without violating the CPU's programmed limits.

When all of the Core i7's resources are active, it consumes a lot more power and gets hotter. Even then, Turbo Boost takes the 4790K up to 4.2GHz without a problem. But when you manually disable the feature in your BIOS, those dynamic adjustments go away and your processor runs at its base clock rate of 4.0GHz.

As far as temperatures go, Intel's fourth-generation Core processor family datasheet states that the thermal control circuit activates at 100 C. The 68 degrees you're seeing are nothing to worry about. In fact, you could probably coax out a couple-hundred more megahertz before encountering cooling constraints.

AHCI, IDE, and RAID

What's up, Doc? I'm absolutely lost. I just learned from the December issue that solid-state boot upgrades should be set to AHCI in the BIOS settings. Besides the fact that I need to use regedit in Windows 10 (already installed) to boot with the AHCI driver, I run into another problem: I already have a RAID setup across my SATA 0/1/2/3 ports. If I change them, I no longer have my RAID setup. I believe my SATA ports can only be set to IDE or Mirror SATA 0/1/2/3. Please help! My motherboard is a Gigabyte GA-990FXA-UD3. **—Vincent King**

THE DOCTOR RESPONDS: The issue of switching between AHCI and IDE in Windows 10 came up in several emails this month. Some folks are saying the Registry Editor approach isn't working. The Doc will set up a couple of systems over the next month to do some testing, and then report back.

It sounds like your situation is more specific, though. AMD's SB950 south bridge supports six SATA 6Gb/s ports, so SATA3_0 through SATA3_5 are attached to the same controller. With your "OnChip SATA Type" set to "RAID" and "OnChipSATA Port4/5 Type" set to "As SATA Type," everything is using AMD's AHCI-compatible RAID driver, which is what you want. To be sure, head over to Device Manager and check under "IDE ATA/ATAPI Controllers".

Gaming or Pro?

I recently assembled a powerful photo/video editing machine composed of an Asus X99-Deluxe motherboard, a water-cooled Core i7-5960X running at 4.7GHz, 64GB of Crucial Ballistix Sport DDR4 memory, a Samsung SM951 512GB NVMe SSD to boot from, and five WD Black 3TB hard drives in RAID 5 for storage. I also installed a Samsung 850 Pro 512GB as a swap drive. I use Adobe Premiere CS6 and After Effects for video editing and rendering.

My GeForce GTX 770 recently stopped working. Colleagues are suggesting that I "upgrade" to a workstation-class Quadro card rather than buying another gaming board. I have read many articles claiming that a GeForce GTX 980 will outperform a Quadro for one-quarter of the price. Do you have any suggestions? **—Roger Rotor**

THE DOCTOR RESPONDS: Stick with the high-end GeForce and you'll get a lot more bang for your buck. Bear in mind that 900-series cards probably haven't been certified by Adobe for CS6, so you'll need to add Mercury Playback Engine hardware acceleration through a well-documented "hack" (this is no longer necessary starting with Premiere Pro CC). The only reason to spend more on a Quadro is if you need 10 bits per color channel and own a display with corresponding support.

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THE BIG SWITCH

The perfect mechanical keyboards for your game-winning fingers

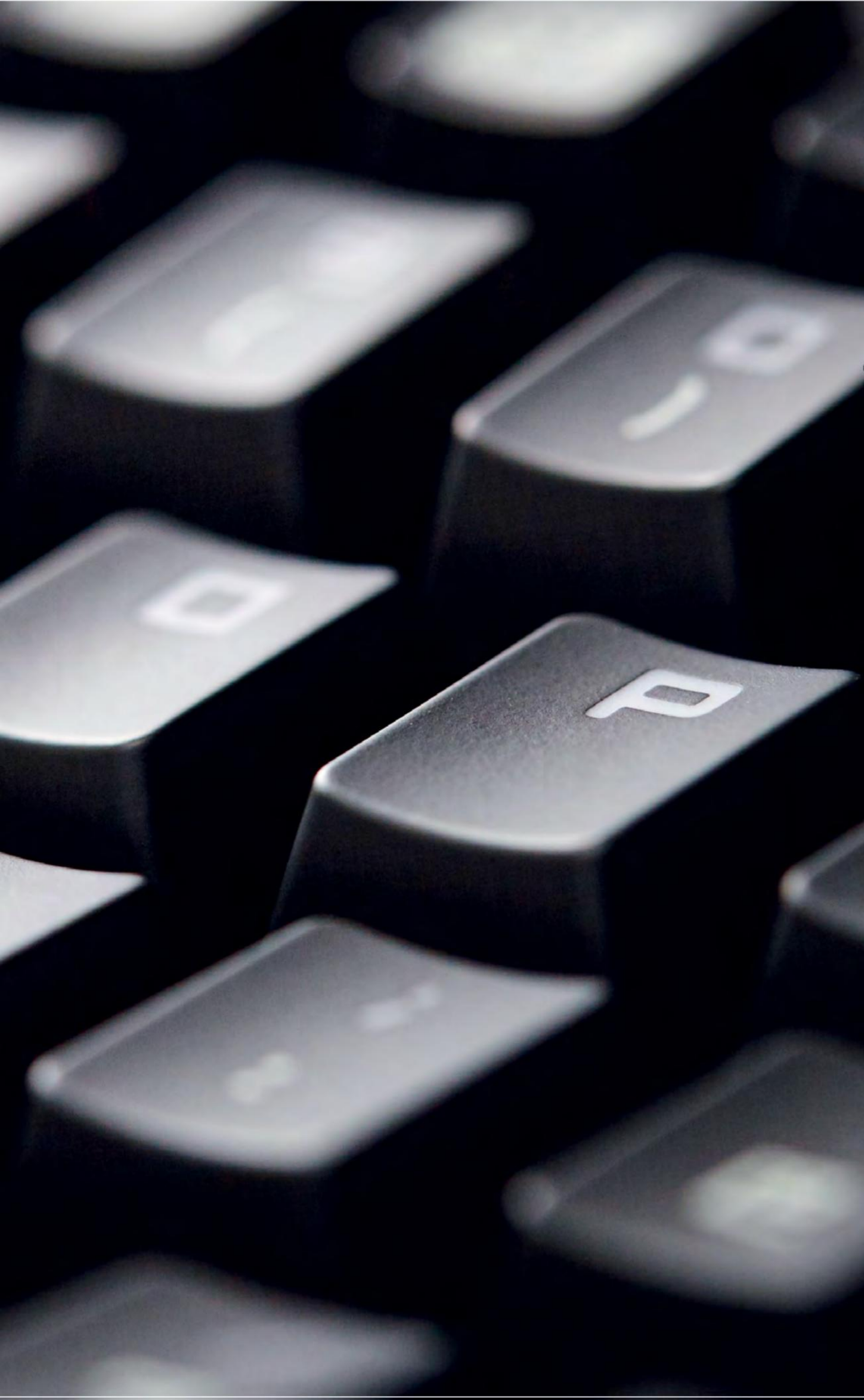
By Zak Storey

Ahh, the sweet twittering of birds singing in the morning—it's enough to elevate the soul. It's a sound that has provided inspiration for the many generations of humanity that have come before us. But you know what else is inspiring? The sound of a good key switch as it clicks solidly and decisively into place on your new mechanical feat of engineering precision and practicality.

A keyboard is more than just a peripheral—it's a product designed to be the most diverse and wide-ranging in your arsenal. A device devised to grace your fingertips with its silky-smooth ergonomic presence. A gadget conceived to help creativity flow from the deepest and most thought-provoking part of that big lump of mushy goo we like to call the cerebral cortex. It allows those chemical reactions we humans call "thoughts" to finally make their way into the digital or physical world. Or you could just, you know, use it to pwn noobs and troll people on forums. Who are we to judge?

Either way, over the last four years, there's been one type of key switch that has dominated the minds of PC gamers, making its way both into our hearts and our wallets. The mechanical switch, first pioneered in the typewriter way back in 1714, has gone through a wide variety of revisions in its lifetime. Starting out as a cumbersome, slow mechanical lever, it eventually evolved into the membrane rubber-domed switch, which we have all now come to loathe.

However, that's not what we're interested in today. If there's ever been a switch that has captured the minds of millions—manufacturers and consumers alike—it's Cherry's MX switch. A switch that came from a very obscure manufacturer, for an entirely different purpose, and it all started way back in 1984, with the introduction of the Cherry MX Black. Read on to find out more about these marvelous clicky wonders, and which keyboard you should buy next.



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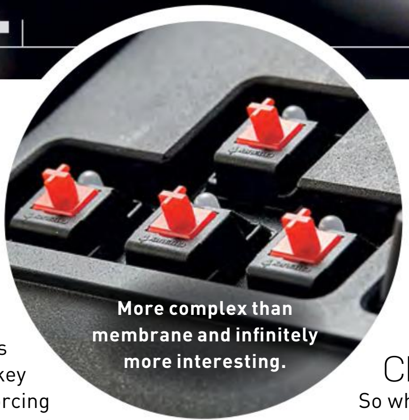
The modern love of mechanical keyboards all started with one fateful switch, and from one fateful company: Filco. Which was undoubtedly one of the first to integrate a mechanical switch into a mainstream gaming keyboard. And, good god, did the community follow suit. With the likes of Corsair, Steelseries, Razer, Logitech, and a variety of other manufacturers taking up the mechanical mantle, it was inevitably only a matter of time before we arrived at today's mechanical-switch-rich climate. Although Cherry's fabled key switches are now proving somewhat difficult to come by, forcing some manufacturers to opt for alternative solutions, they're still the most popular and sought-after switches to date.



More complex than membrane and infinitely more interesting.

HISTORY

It's a little-known fact, but the good old QWERTY keyboard layout wasn't introduced until around 100 years after the initial invention of the typewriter, by a man named Christopher Latham Sholes. And impressive as that was, it's not really up our alley—it wouldn't be until 1964 that MIT's Bell Laboratories and General Electric collaborated to build the world's first video display terminal. This technology combined the cathode ray tubes found inside televisions alongside an electric typewriter, allowing users to see what they were tpying on the screen as it happened. It sounds mediocre by modern-day standards, but for its time it was a phenomenal advancement—the first step toward PC gaming as we know it today.

By the '70s and '80s, the computer keyboard had thoroughly cemented itself into the lives of every PC user out there. IBM introduced the first all-mechanical keyboard with its model M computer. Though, of course, almost all of these were locked up inside university laboratories and not intended for us common folk. In fact, it wouldn't be until the early '90s that the PC would become affordable enough for the average home user. And this was the moment manufacturers left the mechanical switch behind, in favor of the membrane switch we all loathe today, because it was quieter, smaller, lighter, and cheaper to produce. Perfect for the laptop generation of the '90s and noughties.

A blast from the past: the IBM Keyboard.

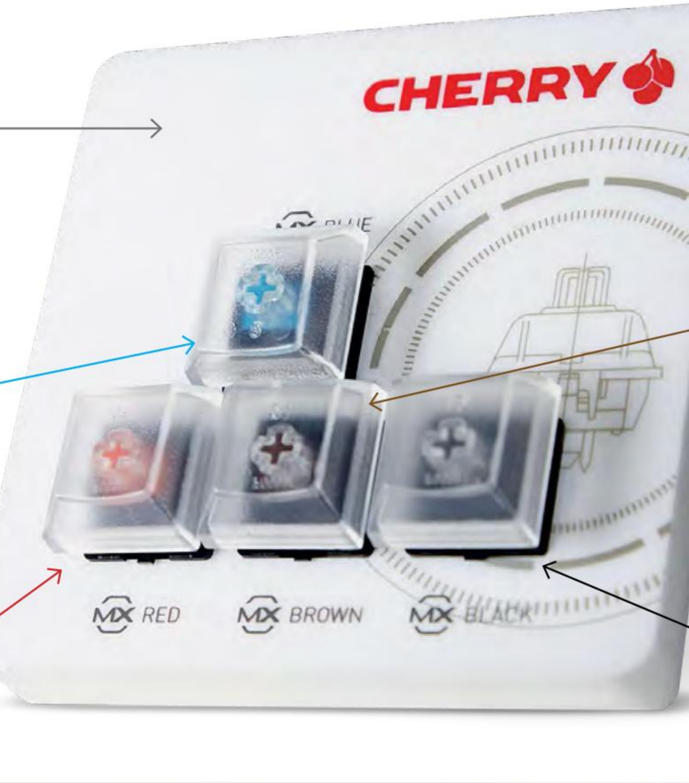
CHERRY MX

So where did it all begin for the Cherry MX switch? Well, back in 1984, with the birth of the first Cherry MX Black key switch, a switch that's still available today. The black switches are notoriously heavy, more so than the more commonly available Cherry MX Reds. A third heavier, in fact. What does that mean? Well, simply put, they're a lot stiffer than their counterparts—they require more force to push down and actuate the key switch, initiating the key that you're typing.

Cherry began life as a company way back in 1953. Originally producing finely tuned precision components for a wide variety of mechanisms, it only began to construct mechanical keyboards in 1967. This makes Cherry the oldest keyboard manufacturer in the world—quite an impressive feat by any measure. However, even though less common names such as Filco built keyboards utilizing Cherry's prestigious key switches, they never really entered the arena of the mass gaming community until later on, with the PC enthusiast's rise to prominence. After all, PC gaming wasn't even really a thing until the late '90s, and even then, the idea of spending copious amounts of your earnings on a keyboard was seen as madness. Fast-forward 20 years and the ecosystem has changed dramatically. With gaming being the number one spectator sport on the planet, there's never been a better time to get into the peripheral scene, and boy, do companies know it.

IBM KEYBOARD ©BLAKE PATTERSON / WWW.FLICKR.COM/PEOPLE/BLAKESPOT/ WIKIMEDIA COMMONS

SWITCH TYPES



CHERRY MX BLUE

If you do a lot of typing, look no further. The blue switch is for you. Featuring the trademark mechanical click, this might not be the best solution if you work in an office but—holy hell—it sounds good. It does require 50g of force to activate, though, making it slower and less responsive than the brown or red.

CHERRY MX RED

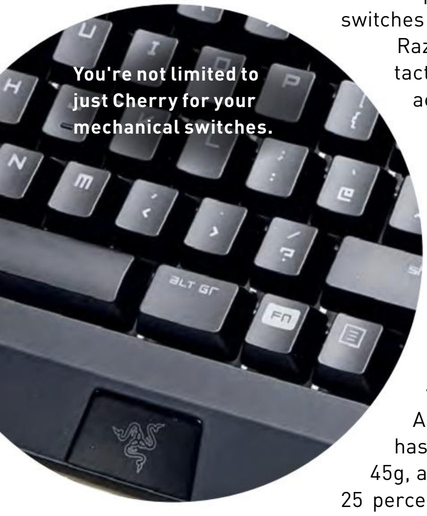
The quintessential gamer's key. This linear switch has the lowest actuation point out of Cherry's lineup, requiring only 45g of force for it to register. It does, however, lack that clicky feel or tactile feedback you'd otherwise get from the typical clicky blue switches.

PERSONAL PREFERENCE

As always, wherever you land on the keyboard spectrum, it all comes down to personal preference. Particularly with Cherry, a company that designs and develops a total of 20 different key types—you really do need to get a feel for which switch you prefer. Not particularly easy, but if you're really curious about which key switch is right for you, you can purchase a small tester sample of Cherry's range from WASD Keyboards, and hopefully alleviate some of your mechanical woes.

OTHER MANUFACTURERS' SOLUTIONS

Of course, it wouldn't be a competitive market if there weren't suitable alternatives out there, and this is no different when it comes to mechanical keys. As Cherry switches become more and more scarce, some manufacturers are outsourcing to other companies to design and develop key switches specifically for them.


You're not limited to just Cherry for your mechanical switches.

Razer, for example, has developed a tactile clicky gaming switch with an actuation force coming in at 50g. Almost identical to the Cherry MX Blue, the major difference is the point of registry on the key switch, which is half as much as the blue. What this means for you is a faster response time without forgoing that signature clicky mechanical feel.

Logitech's Romer G is another alternative, manufactured by the world-renowned peripheral giant. Although still somewhat obscure, it has an actuation weight registering at 45g, and an additional key register point 25 percent less than the next "competing brand," making it the fastest tactile, clicky key switch on the market to date.

CHERRY MX BROWN

The brown switch is meant to sit as a happy medium between the red and the blue. It requires the same amount of pressure to activate, yet features the tactile click feel common in the blue switch, making it ideal for typists as well as gamers.

CHERRY MX BLACK

Looking for a finger workout? The black is currently one of the heaviest switches out there, weighing in at a hefty 60g of actuation force. This linear switch doesn't feature the clicky signature sound of its blue cousin, but if a ton of resistance is your thing, this has to be the one.

THE RGB PHENOMENON, MEMBRANE, AND LED CONTROLLERS

You may have noticed the recent rise of the RGB LED switch. Certainly, the LED controllers seen in peripherals from Corsair, Razer, and other manufacturers are fantastic additions to the peripheral scene. Although they add no practicality to your keyboard, they do provide glitz and glam for those looking to spruce up their gaming cave. Indeed, ever since Corsair announced it was first working on a mechanical keyboard with RGB LED capabilities, the world went insane. RGB isn't something that's exactly new to the peripheral scene, but it was far easier to implement on a membrane keyboard due to the layout and design of the switches themselves, and even those never featured the wide variety of lighting effects that we can see in today's modern controllers.

Initially, LED mechanical keyboards worked off block zones and grouped LEDs. What this meant was that entire segments of the keyboard would be illuminated, with only the functionality of either switching off the entire block or leaving it on. There wasn't the exceedingly high level of control you can achieve from having individually lit switches. Eventually, manufacturers, working closely with Cherry, managed to integrate the two, initially only in one individual color—the traditional gamer's red or a standardized blue, depending on which switch you chose. However as technology advanced and LEDs became more complex, this limitation would become a thing of the past.

It wasn't until Corsair launched the K70 RGB mechanical keyboard in 2014 that we began to see real progress. Integrating an LED controller more often found in monitors than keyboards, Corsair managed to achieve some incredibly advanced lighting effects. And with the K70's launch came the introduction of the Corsair CUE software, allowing LUA coders to write scripts specifically designed to show off what an RGB LED keyboard could do.

And then came the hordes. Now you can't walk around a corner without seeing some peripheral or another touting RGB dominance and astronomical levels of LED coverage. Whether it's Corsair, Razer, Logitech, or Steelseries, everyone and their dog seems to have developed Cylon visor, Mexican wave, 16.8-million-color combination keyboards.

CHERRY MX BOARD 6.0

Cherry's first gaming keyboard

CHERRY IS A COMPANY to which we all owe a debt of gratitude. Without its steadfast stance on the mechanical key switch, we simply wouldn't be where we are today. Indeed, its key switches have revolutionized the keyboard industry, and whether you use Razer, Romer-G, or some other proprietary switch, all of them owe Cherry a pat on the back. But how good are they at moving beyond the clickety keyboard clackers that we've all come to love?

The Cherry MX Board 6.0 is the key manufacturer's first foray into developing a gaming board. Based on the world-renowned Cherry MX Red, this variant touts the bold and ambitious claim of being the planet's fastest keyboard. Indeed, the key caps are two-thirds the size of a standard keyboard, meaning less distance between your finger and the actuation point. And, of course, Cherry is still utilizing a key switch that requires a meagre 45g of force.

What is interesting is the inclusion of a new technology known as Cherry RK. Essentially full analog signal processing, this allows Cherry to achieve a very low latencies, meaning almost instantaneous response times across USB, and absolutely zero ghosting, making this board as fast if not faster than the traditional old-school PS/2 port solutions. Overall, we noticed an increase of around five words per minute on our average type test here in the office, pushing this humble writer from 109 to 114 wpm.

The build quality of Cherry's MX Board 6.0 is stunning. It comes covered from head to toe in a solid aluminum frame, ice-cool to the touch. There's a set of dedicated media keys, and even a magnetic wrist rest included. Unfortunately, you're not greeted by a plethora of LED color options, as you find in some other products at this price point, or a USB passthrough—a shame, considering the cost of the MX. Indeed, the Cherry MX Board is a brilliant entry into the mechanical keyboard world, but there are still a few things that need adjusting.

SPECIFICATIONS

Switch Type	Cherry MX Red
Programmable Keys	No
N-Key Rollover	Full
Passthrough	No

VERDICT 9

Cherry MX Board 6.0

+ **RED DEVIL** Fastest keyboard out there; analog converter; fabulous build quality; dedicated media keys; wrist rest.

− **DUST DEVIL** Lack of LED customization; wrist rest not secure; no USB passthrough; quite pricey for spec.

$220, www.cherrycorp.com

CM STORM QUICKFIRE XTi

All the glitz, none of the glam

COOLER MASTER PERIPHERALS have been around for some time, providing gamers with affordable, dependable entry-level gaming hardware since the dawn of the millennium. The Quickfire lineup has sat snugly in CM Storm's arsenal for many years, introducing its first set of mechanical keyboards to the gaming community.

Indeed, the Storm Quickfire XTi looks to expand upon that, yet retain its simplicity. Unlike some of the other keyboards in our group test, CM Storm has opted out of any form of UI experience on the desktop side of things and replaced it with a more physical set of LED-altering options via integrated function keys.

The Quickfire doesn't feature the usual 16.8 million color set of our other mechanical keyboards here, but instead relies on two powerful combinations of both red and blue. You can get the whole range of mixing those two colors together but not a lot else otherwise. Ironically, there are still plenty of patterns, waves, and reactive typing modes, but that's about it.

The Quickfire XTi comes in Cherry MX Brown, Red, or Blue switches—ours was in Brown. Rather bizarrely, however, it was the loudest of all the keyboards we tested. So much so that one of our colleagues became so enraged they threw a spongy potato at our heads while we were testing.

All in all, we're a little disappointed with the CM Storm Quickfire XTi. It's a solid use of a Cherry switch but the overall implementation and design is very basic. The colors are fairly limited, and there are no passthroughs. On top of that, by far the most annoying feature this keyboard has is its reduced-size Enter key—going from a full-size one to one the size of a Delete key is infuriating in use. That being said, all of these design decisions have, without doubt, been introduced to save money for the customer, making this keyboard a cheap entry into the mechanical marketplace.

SPECIFICATIONS

Switch Type	Cherry MX Red, Cherry MX Brown, Cherry MX Blue
Programmable Keys	Yes
N-Key Rollover	Full (Windows only)
Passthrough	No

VERDICT 8

CM Storm Quickfire XTi

+ **SHARP SHOOTER** Strong LEDs; cable management; solid price point.

− **TRIGGER HAPPY** No wrist rest; small Enter key; no USB passthrough; lack of 16.8 million colors; no dedicated media keys.

$150, http://gaming.coolermaster.com

CORSAIR K70 RGB

The classic, the original, and still the best

LET'S CUT TO THE CHASE: The Corsair K70 RGB is no spring chicken. It's been through hell to get here, through rebrands, beta-testing, and years' worth of trial and error by the two mighty keyboard manufacturers (Corsair and Cherry). So why are we including it? Well, it's still probably the best Corsair keyboard to date. Although it lacks the Vengeance K70's USB passthrough, its overall feature set is miles ahead of the competition.

The K70 RGB was the original, all-premium, Corsair RGB mechanical keyboard. It features a beautifully crafted anodized brushed aluminum chassis, surrounding your choice of Cherry MX Red or Brown switches. On top of that you get a plethora of dedicated media controls, microphone mute, windows lock, and a volume scroll wheel. It also sacks the banks of macro keys dedicated to the much larger K95. Then you get the pleasure of Corsair's RGB CUE technology—unbelievably useful. If you're looking for advanced keyboard lighting schemes, you can go all-out and code your own, or just stick with the standard array. Either way, you're always going to be spoiled for choice.

That said, since the launch of the RGB variant (which loses out on the USB passthrough), the price of the older Vengeance K70 has dropped like a stone. In fact, it's possible to pick one up for less than $90 if you shop around. If you're looking for a cheap, stunning, entry-grade mechanical keyboard, the K70's the one for you.

So ultimately this keyboard comes down to personal choice. If you prefer the feedback of a Cherry MX Brown or the swiftness of an MX Red, you can get that. If you want a simple, well-rounded, sleek gaming keyboard and don't mind losing out on the USB passthrough, it's almost the perfect keyboard. And for the price, you simply can't go wrong. Two thumbs up, Corsair—give us more keyboards like this and we'll love you forever.

SPECIFICATIONS

Switch Type	Cherry MX Red, Cherry MX Brown, Cherry MX Blue.
Programmable Keys	None
N-Key Rollover	Full
Passthrough	No

VERDICT **9** KICK ASS!

Corsair K70 RGB

⊞ **AVENGED** Fantastic design; stunning lighting controller; wrist rest as standard; dedicated media keys.

⊟ **BETRAYED** No USB passthrough.

$166, www.corsair.com

CORSAIR STRAFE RGB

Ever so quiet, ever so LED

WHERE WOULD our keyboard roundup be without a mention of Corsair? Year after year, it has brought us premium-quality components. Whether it's cases, memory, power supplies, or keyboards, you can usually count on Corsair to deliver. So, what's so interesting about the Strafe RGB that we haven't seen before? Well, we'll cut the waffle—it's the switch.

Let's give you a little history as to why this switch exists. Cherry was bought in 2008 by a company called ZF Friedrichshafen. It bought Cherry not because of its fantastic contribution to the computing key switch world, but its ability to craft precision tools and car parts. When Cherry asked its parent company if it could receive funds to build more factories for its key switches, ZF Friedrichshafen said "No," not understanding the nature of the computing scene. Enter Corsair, who said, "We'd like to buy you a factory to help out on production—it'll be yours, but you have to give any new switches you develop priority to us." Thus we have the Cherry MX Silent switch.

It's essentially a dampened Red; it still has the travel and high actuation point that we all know and love, but the bottom-out sound is well dampened, making the switch about half as loud as its MX Red Strafe counterpart. It's still a pleasure to type with, and highly responsive, yet there's something missing without that solid bottom-out feeling. It's almost spongy.

Other than that, the Corsair logo has been moved around, to help hide the stealth LED sails, now hidden in the top-left corner, the plastic frame has stuck around, and you get the full suite of Corsair's RGB CUE technology. It's a far cry from the K70 Vengeance series, but then it's not meant to be that all-encompassing aluminum giant. It also lacks dedicated media keys, but does get away with a single USB passthrough. Handy for throwing files on a flash stick real quick. Overall, it's a well-rounded keyboard, but lacks Corsair's premium feel.

SPECIFICATIONS

Switch Type	Cherry MX Silent, Cherry MX Red, Cherry MX Brown
Programmable Keys	Yes
N-Key Rollover	104 keys
Passthrough	Yes

VERDICT **8**

Corsair Strafe RGB

⊞ **Q, E** New Cherry switch; fantastic LED lighting; detachable wrist rest; USB passthrough; intriguing design.

⊟ **W, S** Plastic outer shell; not a lot cheaper than a K70; wrist rest feels flimsy; no dedicated media keys.

$150, www.corsair.com

DAS KEYBOARD 4C PROFESSIONAL

Pro keyboard with a new switch!

IF YOU'RE A KEYBOARD enthusiast worth half your salt, there will have been three outstanding keyboard names you will have come across. First and foremost, Ducky; secondly, Filco; and finally, Das Keyboard. These three companies were figureheads when it came to pushing mechanical key switches into the gaming market, and all of them have a phenomenal reputation behind them when it comes to the manufacturing quality they deliver for any of their clickety key products.

The 4C Professional is no exception. Das Keyboard's latest professional-grade iteration of mechanical keyboard is a real sight to behold. Indeed, not everybody is looking for all the usual glitz and glam of the traditional gaming-grade, RGB-lit, macro-keyed, mechanical, angled, ergonomic, liquid crystal display behemoth. In fact, in an office environment, that's hardly a viable typing solution—unless, of course, you really enjoy looking like a bit of an idiot. And the 4C Professional looks as though it should fill that space in the market. It provides a simple, crisp, clean design, with white non-illuminated key caps, resting on top of custom-designed Greetech Brown switches. The key caps do give us a little pause for concern, as they appear to have an almost raised sticker appearance, but we gave it our best shot and they don't seem to damage easily, if at all, no matter how much we attempted to scratch off one of the keys.

What's most curious about this keyboard, however, is the switch itself. Instead of the traditional Cherry MX Switch, Das Keyboard has gone with a Greetech switch. Notably a Brown Greetech switch. Not to be confused with the Cherry MX variant, Greetech's switch has a far more noticeable tactile click to it. Interestingly, it still has the same actuation point and it still requires the same amount of force to press down, yet there's a tone of Cherry MX Blue to it on the click instead. Cheap rip-off or bespoke key? We'll let you decide.

SPECIFICATIONS

Switch Type	Greetech Brown Switch, Greetech Blue Switch
Programmable Keys	No
N-Key Rollover	Full (Windows only)
Passthrough	Yes

VERDICT

7

Das Keyboard 4C Professional

⊞ **SEHR GUT** Nice design; compact; interesting typist switch; aluminum frame.

⊟ **NICHT GUT** No wrist rest; lack of suitable angled mounts; no other bells or whistles.

$143, www.daskeyboard.com

G.SKILL RIPJAWS KM780 RGB

The world's smallest Enter key

BETTER KNOWN for its phenomenally long history with memory, G.Skill is hardly a brand you'd expect to jump into the peripheral world. But if Gigabyte can do it, why not G.Skill? The question is, what can G.Skill innovate on that all the other peripheral manufacturers can't?

Certainly, the KM780 is a sight to behold. It takes the ludicrous design styles that G.Skill is known for and slaps them on a keyboard, with enough bells and whistles to form a one-man band. Or at least, so it would appear. Constructed partly from aluminum, partly from plastic, the KM780's lavish exterior certainly has the shock factor. It's when you look under the surface you notice some nasty chinks in its armor.

The LED controller, for instance, although able to perform the usual plethora of lighting effects, lacks the precision and fluidity of those of its competitors. Even the interface doesn't lend itself to easy use. The LEDs, although of the usual 16.8 million RGB variety, don't extend across the entire keyboard. The dedicated media keys, scroll wheel, volume indicator, and macro mode keys are all membrane switches, and all stuck on red lighting. This can contrast severely if you opt for a different color on the rest of the board. But by far the worst thing about this keyboard is the size and shape of the Enter key, a crucial button for any PC enthusiast's in-game spiel. It's far too small, and in our testing we were constantly hitting the key above it as well as Enter.

Granted, the inclusion of dedicated media keys is a nice feature to see—in fact, living without a volume scroll wheel is nigh-on impossible for some of our writers. And even the USB and 3.5mm passthrough are good to have. But the overall construction of the board, the small oversights, and the membrane keys just bring this board sailing back down to the bumpy verdict our judge, jury, and executioners feel compelled to decree.

SPECIFICATIONS

Switch Type	Cherry MX Red
Programmable Keys	No
N-Key Rollover	Full
Passthrough	No

VERDICT

7

G.Skill Ripjaws KM780 RGB

⊞ **JAWS** RGB lighting; media keys; macro keys; aluminum construction; cherry MX Brown switch.

⊟ **NEMO** Tiny Enter key; not very bright; odd lighting controller; poor software; membrane switches; plastic construction.

$160, www.gskill.com

LOGITECH G910 ORION SPARK

The most perfect switch ever?

WHEN LOGITECH RELEASED its first G15 gaming keyboard back in 2005, we were taken aback by how well-thought-out it was. As far as keyboards went, it was the first of its kind to feature an LCD display, alongside a vast array of macroable keys, and the ability to disable the Windows button, which was revolutionary for its time. And looking at the G910 Orion Spark, this isn't an area Logitech has finished innovating in just yet.

So let's start with the G910's most intriguing feature: the switch. Logitech's custom-designed Romer-G is outstanding. It has a very small amount of travel, almost comparable to the Steelseries QS1. However, it differs in one specific way: It's essentially a clicky switch. It has a small amount of tactile feedback, something we usually associate with the Cherry MX Brown, but at the same time, it sounds like an MX Blue, only with half the travel. And on top of that, it's far quieter as well, and it's done without sacrificing that signature sound. On top of this, Logitech has built the RGB LEDs into the center of the switch, under a fine mesh gauze, ensuring the light is merged evenly. This provides well-rounded, accurate colors, with perfect, centered lighting.

So the key switch is fantastic, but where's the flair? Well, if the design is anything to go by, it fits into Logitech's portfolio of gaming peripherals. You're graced with a total of nine macroable keys, split horizontally above the F keys and vertically along the left-hand side, presumably to save space. Of course, you get those typical traits pulled from its now 10-year-old ancestor, the G15. Three banks of macros, an on-the-fly macro recorder, Windows key lock, and a full array of dedicated media keys. Logitech has moved away from a dedicated screen, and has opted for a smartphone app and slide-out holder instead, which, although it doesn't charge your phone, is sturdy. This is an all-around fantastic keyboard, and if you can get past the design style and lack of USB ports, it's damn near perfect.

SPECIFICATIONS

Switch Type	Logitech Romer-G
Programmable Keys	27 programmable keys
N-Key Rollover	113 Keys
Passthrough	No

VERDICT
9

Logitech G910 Orion Spark

➕ **THE HUNTER** Brilliant switch; innovative macro keys; dedicated media keys; full RGB suite; smartphone app; wrist rest as standard.

➖ **THE HUNTED** Lack of USB or audio passthrough; media keys and Logitech G logo not RGB; design might not be for everyone.

$180, www.logitech.com

RAZER BLACKWIDOW CHROMA

Maniacal clicky keys of destiny

RAZER'S UNIQUE MECHANICAL key switch has been making the rounds for quite some time. Although a response to the limited availability of Cherry's world-famous switches, you shouldn't write it off just yet. The key switch was first seen in 2014, and feels like the perfect mix between a Cherry MX Blue and a Red, taking the best of both and merging them into one. The actuation point is incredibly low, but it does require you to physically feel the click of the switch before you actually receive a response from the keyboard itself. This makes it particularly enjoyable for typists, though more hardcore gamers may not like the incredible urge to then bottom-out the key following through.

Otherwise, Razer spoils you with its new Chroma series LED controller, featuring a wide variety of lighting features and effects, and you get the standard modern affair of up to 16.8 million color combinations, of course. The lighting is superb, as not only does it illuminate the key cap, but the white keyboard guard below the switches as well, reflecting the light back up and around the switch, making this an absolutely stunning piece of hardware to look at and use, especially with reactive mode enabled.

No sign of dedicated media keys or a wrist rest on this particular edition of the Blackwidow, which is unfortunate. Luckily, the standard F keys are enabled by default, meaning you certainly won't be penalized if you want to take advantage of every key available to you in game.

Apart from that, the design and feel of the Blackwidow Chroma is glorious. With a fantastic soft touch finish, solid construction, and overall nice angular feel, the keyboard has very little flex at all, which is incredibly impressive for a non-aluminum chassis, to say the least. All in all, if you're a gamer looking for a stunning, premium, clicky-sounding key switch, and a full-size keyboard, you should definitely consider picking up one of these beauties.

SPECIFICATIONS

Switch Type	Razer Switch, Razer Silent Switch
Programmable Keys	Yes
N-Key Rollover	10 keys
Passthrough	Yes

VERDICT
9

Razer Blackwidow Chroma

➕ **SHARP** Lovely key switch; great LED controller; nice design; solid construction; USB passthrough.

➖ **RUSTY** Lack of dedicated media keys; can't swap between media/function keys by default.

$150, www.razerzone.com

ROCCAT RYOS MK PRO

The old bruiser still has love to give

ROCCAT IS A WELL ESTABLISHED brand when it comes to peripherals. Its deceptive mouse ranges are incredibly far-fetched, packed with as many buttons, frills, and outlandish design styles as you could imagine. But does that mad flair for bonkers design crop up along the keyboard side of life? Can it innovate in such a crowded marketplace?

Our version of the Roccat Ryos MK Pro came packed with Cherry's own MX Brown switch, providing a sharp tactile response and feel. Nothing new here, then. The Ryos MK Pro's outlandish look is certainly enough to grab your attention but it doesn't distract from the fact that this is a chunky keyboard. With Roccat's decision to fully integrate the wrist rest into the board itself, you're going to want to ensure you have a big enough desk to throw this thing on to.

For your money you get a single LED color, five macro keys, three rather odd-looking spacebar macro buttons, and the now rather unfortunately common media functions bound into the F keys. In short, this keyboard is old, and the overall look isn't particularly good; there's a severe lack of premium feel. It's not all doom and gloom though—the Ryos does manage to pull back a few points thanks to its two USB ports and audio passthroughs. But is that enough to save this arthritic champion?

The problem here is that Roccat just hasn't provided a premium option in some time. It's something that contrasts quite heavily with its mouse lineup. And although this is a fantastic entry-level mechanical keyboard, to us it looks as though it's priced for the wrong audience. It needs some TLC. Admittedly, it does have a fairly well-rounded feature set, including those USB passthroughs, but for the size it would have been nice to have seen some dedicated media keys, perhaps a more modern LED controller, a detachable wrist rest, and some form of premium aluminum frame. Something extra just to give it a bit more glitz so it could run with the big boys.

SPECIFICATIONS

Switch Type	Cherry MX Red, Cherry MX Brown, Cherry MX Blue, Cherry MX Black
Programmable Keys	No
N-Key Rollover	30 keys + 8 modifiers
Passthrough	Audio & USB

VERDICT **6**

Roccat Ryos MK Pro

⊞ **RYU** Cherry MX Brown; audio and USB passthrough.

⊟ **ZANGIEF** Plastic construction; single LED color; integrated wrist rest; lack of dedicated media keys; plain finish; spacebar buttons make no sense.

$160, www.roccat.org

STEELSERIES APEX M800

Steely enough to steal our cash?

STEELSERIES IS POSSIBLY better known for its prestigious history with gaming mice than its keyboards, but that hasn't stopped this Danish manufacturer from spreading its wings into mechanical keyboards.

The mechanical switch inside the Apex M800 isn't from the fabled Germanic Cherry factories—it's one of Steelseries's own, the QS1. Touting an entirely different design than other mechanical solutions, the key feels and acts like an odd hybrid between a mechanical Red and a membrane switch of yesteryear. It's very responsive, yet feels damp, to the point that the traditional sound of the clicky keyboard is almost all but mute. The actuation point of the key is 25 percent less than a traditional Cherry MX Red; in fact, it's incredibly easy to bottom-out, meaning super quick response times.

But if you're looking for a feature-rich keyboard, the Apex M800 comes brimming with gadgets and gizmos. Quick macro keys, game modes, function keys, individual key lighting, and effects—hell you can even play *Minesweeper* on it! (No, seriously, you can.)

As far as negatives go, there's not a great deal to talk about besides the design of the switch. The only potential problem we can see is the lack of dedicated media keys, as they're bound in with the traditional function keys. That said, if you do hit the Steelseries function key, it dims the entire keyboard except the media and system control keys—a nifty feature.

Ultimately, whether you like this board comes down to whether that switch is enough to sway you. It's a bit of an odd experience. If you're a typist more than a gamer, then potentially you ought to be looking at a more traditional Cherry MX Blue or even Razer's mechanical solutions. Otherwise, this is ideal for any gamer looking to maximize their reflex-based potential. In fact, it gives us fond nostalgic fuzziness about the innovations we saw when first using Logitech's G15, the original gamer's keyboard, way back when.

SPECIFICATIONS

Switch Type	Steelseries QS1
Programmable Keys	Yes
N-Key Rollover	256 keys
Passthrough	Yes

VERDICT **9**

Steelseries Apex M800

⊞ **SUMMIT** Unique key switch; individual key lighting and effects; super responsive; USB passthrough; unique media key solution; macro keys and incredible UI.

⊟ **PLUMMET** Personal preference on key switch; small amount of flex.

$178, www.steelseries.com

CyberPower recommends Windows.

AMD

Windows 10

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AMD 7.1 · Syber® Wireless Keyboard · Logitech® Controller

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CORSAIR® 8GB DDR3 1600Mhz Dual Channel Memory
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HOW WE TESTED

All keyboards were tested for a minimum of at least two days, using various typing tests, games, and work-based activities. All software was installed and tested on Windows 10.

KEYBOARD SPECIFICATIONS

	Cherry MX Board 6.0	CM Storm Quickfire XTi	Corsair K70 RGB	Corsair Strafe RGB	Das Keyboard 4C Professional
Switch Types	Cherry MX Red	Cherry MX Red/Brown/Blue	**Cherry MX Red/ Brown**	Cherry MX Silent/ Red/Brown	Greetech Brown/ Blue
Key Durability	50 million key operations	50 million key operations	**50 million key operations**	50 million key operations	60 million key operations
Fully Programmable Keys	No	Yes	**Yes**	Yes	No
Dedicated Macro Keys	No	No	**No**	No	No
Media Keys	Yes (via F keys)	Yes (via F keys)	**Dedicated**	Yes (via F keys)	Yes (via F keys)
N-Key Rollover	Full	Full NKRO *(Windows only)*	**Full NKRO**	104 keys	Full NKRO *(Windows only)*
Passthrough	No	No	**No**	Yes	Yes
RGB Lighting	Single color: red	Dual color: red and blue	**Full RGB**	Full RGB	N/A
Wrist Rest	Detachable	No	**Detachable**	Detachable	No
Dimensions *(inches)*	17.9x9.3x1.1	17.3x5.1x1.6	**17.2x4.9x1.2**	17.6x6.7x1.6	15.5x6.1x1.1

KEYBOARD SPECIFICATIONS

	G-Skill Ripjaws KM780 RGB	Logitech G910 Orion Spark	Razer Blackwidow Chroma	Roccat Ryos MK Pro	Steelseries Apex M800
Switch Types	Cherry MX Red	Romer-G	Razer Switch/ Silent Switch	Cherry MX Red/ Brown/Blue/Black	Steelseries QS1
Key Durability	50 million key operations	70 million key operations	60 million key operations	50 million key operations	60 million key operations
Fully Programmable Keys	No	Yes	Yes	No	Yes
Dedicated Macro Keys	6 keys	9 keys	5 keys	8 keys	5 keys
Media Keys	Dedicated	Dedicated	Yes (via F keys)	Yes (via F keys)	Yes (via F keys)
N-Key Rollover	Full NKRO	113 keys	10 keys	30 keys plus 8 modifiers	256 keys
Passthrough	Yes	No	Yes	Yes	Yes
RGB Lighting	Full RGB	Full RGB	Full RGB	Single color: blue	Full RGB
Wrist Rest	Detachable	Integrated	No	Integrated	No
Dimensions *(inches)*	20.4x6.8x1.9	19.9x9.6x1.4	18.7x6.7x1.5	20x8.8x1.3	19.4x6.7x1.8

AND THE WINNER IS...

CORSAIR K70 RGB

THIS IS AN INTERESTING ONE. Keyboards (like all peripherals) are incredibly personal. It's a product that you're going to spend potentially thousands of hours using. They have to be durable, comfortable, and useful. All key switches aside, it's hard for us to argue for any keyboard more than the current iteration of Corsair's K70 RGB.

Its sleek and elegant design is coupled with a phenomenal feature set. Dedicated media keys, CUE lighting technology, and BIOS response options bring it leaps and bounds ahead of the competition. As far as keyboards go, it just looks good. It's not too extreme in any one dimension, and that's crucial. Yes, we're PC enthusiasts, and most of us like to game, but we don't want flared keyboards with fancy key caps, red streaks, and extravagant design. PC gaming has evolved beyond that, something that Corsair continues to capitalize on. If you're looking for an affordable, premium grade, mechanical keyboard, there's no better time to pick up an (almost) old-school K70 RGB, in whatever flavor switch tickles your fancy.

That being said, if this group test's winner was based on key switch alone, the Logitech G910 Orion Spark would be top dog, hands down. It's one of the quietest mechanical switches we've ever heard, and it achieves that without sacrificing any of the tactile response that you'd usually associate with a standard Cherry MX switch. It's blisteringly fast, and remarkably nice to use. If only it were in something a little more professional looking, it could have easily taken this group test by storm. Razer's mechanical switch comes in at a close second on this one. Although more oriented for the typists out there, it has a beautiful feel to it, and a sound that'll make you weep. Don't let the worrywarts get to you—no, it's not a Cherry switch, but that doesn't mean you shouldn't give it a chance. After all, you're still covered by Razer's warranty on this one, and a key switch life expectancy of 60 million or more should see you fit for a few years.

DIFFERENT STROKES

If you're looking for total customizability and a user interface that'll knock your socks off, the Steelseries Apex M800 is an impressive feat of software engineering. Although the key switch is something of an acquired taste, blending the lines between chiclet and mechanical, the level of control you have over what you want the keyboard to do is astronomical. Arguably, you may not want to use the F keys as an ammo indicator, but either way, the option is always there. If you're a fan of chiclet-style, low-travel keyboards, the Apex M800 follows that tradition admirably. Whether or not that improves your response times, if it's what you like, it's what you like, right?

The real let-downs of this group test came from the older boards, although that wasn't a big surprise. We included them because they're commonly used, and are still available from some manufacturers. Roccat in particular suffered here, mostly due to a lack of innovation over the last couple of years. Which is a shame, because its mouse range shows that the company certainly does have some incredible potential when it comes to the peripheral design front. We would love to see Roccat shake up the market next year with a fully RGB, mechanical, full-featured keyboard. Just in case anyone from Roccat is listening.

So, where are we heading ultimately? In this group test alone, we had four unique key switches from the likes of Razer, Logitech, Steelseries, and Das Keyboard. All of which were notably different from one another. With Cherry now not being able to keep up with the demands of the PC gaming industry, who knows which other companies may jump ship in favor of developing their own custom keys? As with all things, competition is certainly no bad thing, and with Cherry receiving so much of our attention lately, this still gives it the opportunity to push more of its resources into research and development, meaning better key switches for us, the users. So to answer the question slapped at the top of this group test, should you make the big switch to mechanical? Honestly, you might not have a choice in a year or two, but as far as we can see, that's really not an issue.

> “Its sleek and elegant design, and phenomenal feature set bring it miles ahead of the competition.

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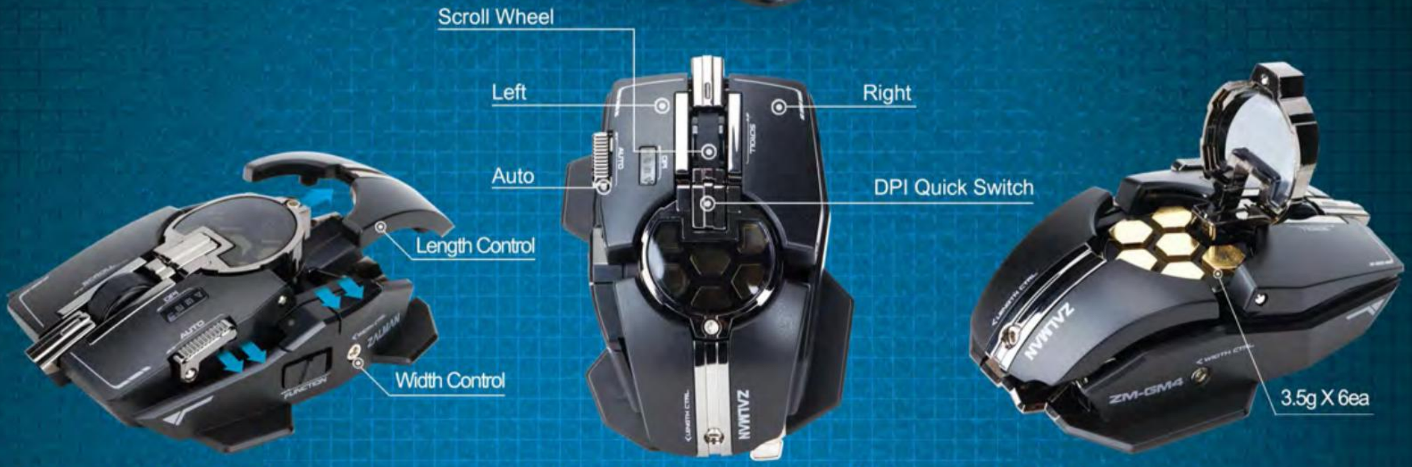
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Robust Features for Gaming

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- Rapid DPI switching
- Auto fire button (2 inputs per click)

Customized Movement

Up to six 3.5g weights can be equipped and adjusted for optimal maneuvering

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2016 TECH PREVIEW

Over the next 12 months, our notion of what a computer is, and how we interact with it, will change. But that's just the start of what's to come—this year is shaping up to be a pivotal one for graphics, processors, storage... pretty much everything in fact

by the Maximum PC staff

NZX

TECH PREVIEW 2016: VR AND AR

The year in which all our realities could change

We're barreling headlong into 2016, and it's finally going to be the year virtual reality becomes an actual reality. First and foremost, the technology in the optics, screens, and motion-tracking has advanced to the point where a great experience is now possible. But it's also important to note that the hardware in our PCs is getting to the point where more and more of us are going to be able to afford the ticket price of a VR-capable gaming rig. So, what are the main contenders for the VR crown?

OCULUS RIFT

We've got to start with the Facebook-owned Oculus Rift. It kickstarted the latest VR revolution, and with the Zuckerberg billions having been poured into the coffers, it means Oculus has been able to hold back its release to make sure it sparkles at launch next year.

We still don't have a final release date for the consumer version of the Rift, but we expect it in the first quarter of 2016. Final pricing is also quite elusive, but we've been told to expect something in the region of $300–$400.

The hardware is some of the most powerful being specced out right now. The screen tech is a Samsung OLED display with a resolution of 2160x1200, delivering 1080x1200 per eyeball. The refresh rate is important, too, at 90Hz, with a low-persistence screen to minimize blurring and avoid it turning into your personal vomit comet.

The headset is only part of the experience, and Oculus has also unveiled new wireless controllers—the Oculus Touch, sold separately. They have crescent moon–style motion-tracking around the hand, an analog trigger and stick, as well as a pair of buttons. Oculus has released the minimum specs for your VR rig too—a GTX 970 or AMD 290, with at least a Haswell i5 CPU, and 8GB or more of RAM.

HTC VIVE

The contender to the crown is HTC's Vive VR system. Or should that be SteamVR? Developed in partnership with Valve, Vive is the name of the developer edition, so Valve could claim the SteamVR nomenclature at launch. Which is likely to be in early 2016 again. There have been rumors about a December launch, but the main thrust of SteamVR will likely be throughout 2016, even if a limited number are released before the end of 2015.

The specs are very similar to the Rift—with a 2160x1200 display resolution, and 90Hz refresh rate. The difference is it's meant to be used in a standing position, with 70 sensors (accelerometer, gyroscope, and so on) in the headset. Wireless cameras will deliver a play area of 15x15 feet.

Its controllers look like a Steam Controller cut in two, with each having a trackpad under the thumb, a trigger, and a few buttons. There's also a hat with a raft of sensors to keep tabs on top.

SteamVR is likely to have similar PC demands as the Rift, as it needs to drive that resolution at smooth enough frame rates to maintain fluid motion in your virtual world.

MICROSOFT HOLOLENS

Standing an outside chance of arriving in 2016 is Microsoft's Hololens. It's more augmented than virtual reality, with the visor being see-through, but allowing a digital overlay to be dropped on to the surface in your field of view.

That field of view is limited, not stretching to the edges of your vision, but it allows you to "project" images in front of you. Microsoft demoed the device throughout 2015, with *Halo* and *Minecraft,* and is going to start shipping developer versions at the start of 2016. The price? A cool $3,000. Ouch.

Consumer versions are said to be in the "Windows 10 timeframe," though, which could mean well outside 2016.

It's the only wireless device of the three, needing no tethering, and potentially with wireless charging, too. It's also the only one to let you wear glasses if you're ocularly impaired. No official specs have been given, but the rumors have it running at 1080p, with potentially a next-gen Intel Atom processor at its heart.

The Rift comes with an Xbox One pad, but the wireless controllers are another step in immersion.

The current HTC Vive/SteamVR is more bulky than the Rift, but is more designed for physical movement.

ENTHUSIASM FOR SKYLAKE TAKE TWO

Intel has plans for enthusiast-class components

There's a good chance Intel has multiple options lined up, and much will depend on how AMD's new Zen CPU turns out. However, we still have certain expectations for Intel in terms of silicon sorcery. For starters, there will likely be a double whammy of high-end chips for its high-end desktop platform in 2016.

These chips are the "E" variants of the double-stacked Broadwell and Skylake architectures. We say "double-stacked" because of the close proximity of their launches in mainstream desktop format—the Core iX-5000 and 6000 series processors. In other words, just as mainstream Broadwell and Skylake CPUs arrived in quick succession in 2015, Broadwell-E and Skylake-E are both due in 2016. Precise timing isn't set in stone, but expect Broadwell-E in spring, with Skylake-E rocking up toward fall.

Specs-wise, Broadwell-E looks familiar, with a mix of six- and eight-core models for the existing LGA2011v3 socket. All indications are also that Broadwell-E will be compatible with existing Intel X99 motherboards.

The shape of Skylake-E is harder to predict, but it will likely require a new socket and a new chipset. Dare we hope for more than eight cores in Skylake-E? It's certainly possible, given Skylake-E Xeon chips for servers will get as many as 28 cores.

However, where the 2016 story for Intel gets complicated is 10nm chip technology. Intel was planning to roll out its new 10nm Cannonlake chips in 2016. Problem is, 10nm won't be ready until 2017. That's a problem for Intel's "Tick-Tock" chip launches, which see new CPU designs and new production processes rolled out in alternate years.

Intel's solution is an interim chip family known as Kaby Lake. It's best thought of as a refresh of Skylake than a properly new CPU family. At this stage, little to nothing is known about Kaby Lake's specifications or performance. In any case, unless AMD does something seriously exotic with its Zen CPUs, those Kaby Lake chips probably won't be available on the desktop until the very beginning of 2017.

So, with Intel having difficulty ramping its 14nm processors and the 10nm node delayed, is Moore's Law—which states that computer chips double in complexity or halve in cost every couple of years—dead? The simple answer is yes. Progress will continue, but at a slower pace. Instead, some new paradigm is needed, be that quantum computing, or some other fundamentally new technology.

MEDITATING ON THE FUTURE

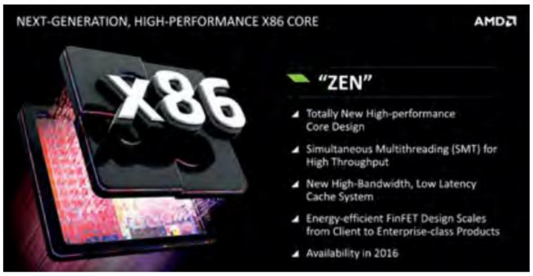
A defining moment for AMD's processor arm

AMD's Zen might be the most important thing to happen to PCs in 2016. It's the company's long-awaited new CPU architecture—designed to turn things around not just for AMD, but for everyone who loves PCs. Even Intel. The problem with AMD's processors being off-pace is that it has let Intel off the hook. Which is possibly why even Intel's CPUs have only seen subtle improvements.

Funnily enough, the most promising aspect of Zen isn't some hitherto unheard of special technological sauce or even the chip itself. It's the guy who was in charge of designing it. Jim Keller helmed development of the AMD Hammer architecture, also known as the original Athlon 64, and the last AMD chip that really took the fight to Intel. Keller had left AMD post-Athlon 64, and spent several years at Apple, developing the A4 and A5 chips for iPhones and iPads. He is one of the best in the business.

As for what we know about Zen, the technical details are few and far between. But it's an all-new CPU core, that much is clear. AMD has also said that Zen is a performance PC architecture—not a jazzed-up mobile chip. It's designed to do heavy computational lifting. What's more, AMD has prioritized Zen over other projects, including plans for ARM-based K12 chips. The message is clear: AMD is serious about high-performance x86 chips for desktop.

AMD is ditching everything that went into its bold Bulldozer design that debuted in 2011. In other words, the modular design that sees integer units sharing floating-point resources is a goner. In its place, AMD has cooked up a more conventional approach, involving big, powerful cores. The priority, AMD says, is improving IPC, or instructions processed per clock cycle. AMD says IPC will be up by around 40 percent over its existing CPUs.



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AMD's prodigal son, otherwise known as Zen.

Zen will also introduce symmetric multithreading—the ability for a single core to process two software threads in parallel. So that's a big, fat core with multithreading support. Yup, it sounds exactly like a current Intel CPU core. Rumor has it the first Zens will have up to eight cores.

Zen will also see AMD CPUs produced on a much more modern FinFET silicon production process—probably GlobalFoundaries's new 14nm process. Whatever, an improved process should help dramatically with everything from clock speeds to power consumption. Zen will go into a new socket known as AM4, and will also support DDR4 memory. From every angle, it looks extremely promising.

GRAPHICS CARDS

Rendering brave new worlds

Every year inevitably brings a lot of new and exciting technologies, and there's always plenty of anticipation. For the graphics industry, however, the hype may actually fall short of the technological advances, with 2016 shaping up to be a banner year.

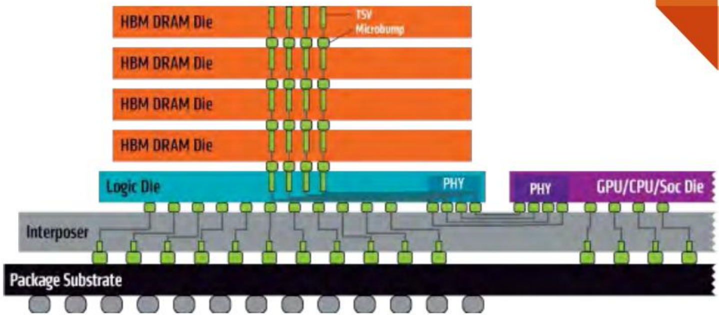
GPU vendors have been stuck with 28nm process technology since early 2012. Briefly, 20nm focused on low-power designs for smartphones and tablets, but high-performance 20nm never materialized for GPUs. The next node from TSMC will be 16nm FinFET, representing more than a typical process shrink, and the addition of FinFET should further improve performance and clock speed.

With the large jump in manufacturing processes, a jump in transistor counts is expected. Nvidia is at 8 billion with GM200, while AMD uses 8.9 billion in Fiji, so it's possible—and rumors suggest it's likely—that the fastest chips will double the number of transistors. Which may make AMD's announced-but-not-yet-released dual-Fury card a bust. Why buy a dual-GPU card if you can get a single GPU with better performance and lower power requirements?

Both AMD and Nvidia are slated to move to new process technology, Nvidia with its Pascal architecture (GP104, GP106, etc.), and AMD with Arctic Islands (Greenland, Baffin, and Ellesmere). The competition might even result in a full-blown top-to-bottom launch of new GPUs. Little is known about the architectural details of either company, but even a simple die shrink and scaling to more graphics cores would yield a massive increase in performance, and there will be architectural enhancements as well.

In 2015, AMD released the first HBM (High-Bandwidth Memory) GPU with Fiji, packing 4GB of HBM and delivering 512GB/s of bandwidth. HBM 2.0 looks to double the bus width and quadruple the max amount of RAM per stack, meaning 16GB of HBM 2.0 with a full 1TB/s of bandwidth is possible. 16GB seems overkill, however, and it should be possible to still provide 1TB/s with only 8GB of HBM 2.0.

The problem with HBM is that it requires a silicon interposer to interface with the HBM dies, making it more expensive. There's a reason AMD's Fiji is the only HBM 1.0 GPU to date; it starts at $550, and was originally rumored to target the $1,000 price point. HBM is a great fit for ultra-high-end GPUs, but what about the mere high-end GPUs in the $300 range? GDDR5 has been used for many years now, and it will likely continue to see use for years to come, but Micron has detailed the next iteration of GDDR: GDDR5X.

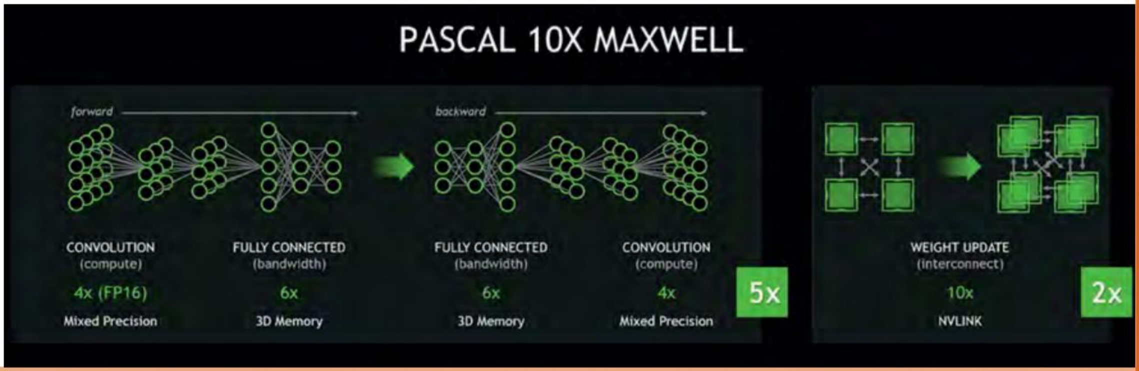


AMD has paved the way for the next generation of GPU memory.

DDR stands for "Double Data Rate," using both the rising and falling clock edges for data transfers. Over the years, the amount of data fetched per cycle has increased. GDDR5X doubles the pre-fetch to 16 words, or 64 bytes, doubling the bandwidth potential. The benefit of GDDR5X over HBM is that it can be used with lower-tier designs. If a manufacturer wants to build an inexpensive $100–$200 GPU with 2GB RAM, HBM is almost out of the question. GPUs with DDR3 have been hanging around almost purely for cost considerations, but with GDDR5X on the horizon, hopefully we'll see less use of DDR3, and move to GDDR5 at a minimum, with GDDR5X occupying the middle tier.

The hardware isn't the only thing changing. DirectX 12 is out now, but we're still waiting on the games. Several are slated to launch during the 2015 holiday season, but some of these will slip into 2016. Heavy hitters include *Deus Ex: Mankind Divided, Fable Legends, Far Cry Primal, Ashes of the Singularity, Star Citizen, Hitman,* and more. OpenGL has a similar low-level API called Vulkan, which builds on AMD's Mantle API. Little has been said of any official Vulkan titles, but unlike DirectX, Vulkan provides the possibility of cross-platform support, so Linux users aren't left out.

2016 could be the biggest inflection point in the graphics industry since the invention of the GPU in 1999. Bring it on!


PASCAL 10X MAXWELL

CONVOLUTION (compute) 4x (FP16) Mixed Precision

FULLY CONNECTED (bandwidth) 6x 3D Memory

FULLY CONNECTED (bandwidth) 6x 3D Memory

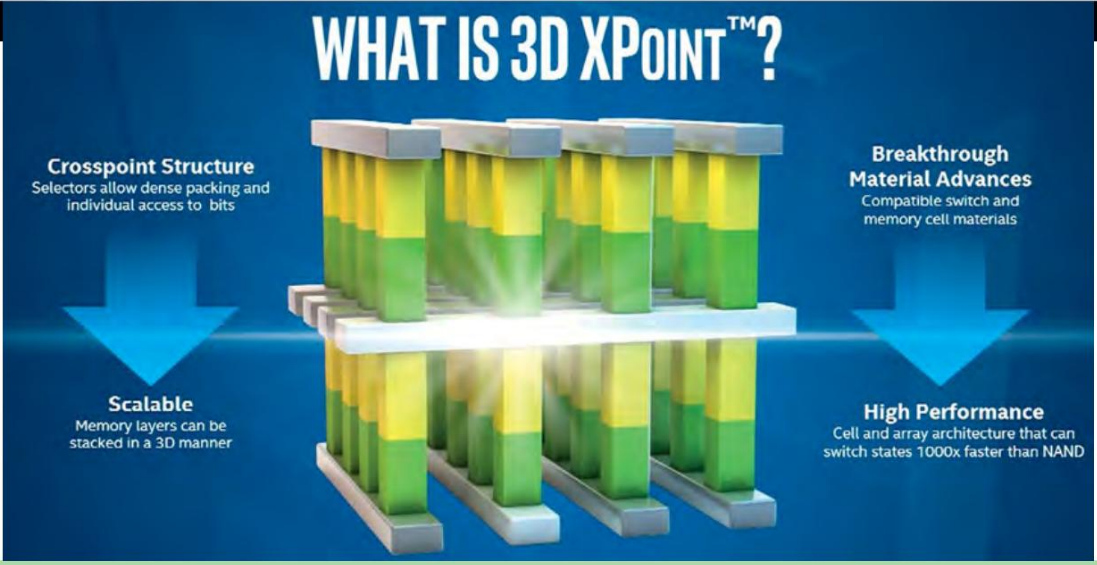
CONVOLUTION (compute) 4x Mixed Precision

5x

WEIGHT UPDATE (interconnect) 10x NVLINK

2x

Nvidia's promising some incredible performance figures with the new 16nm process.


WHAT IS 3D XPOINT™?
Crosspoint Structure
Selectors allow dense packing and individual access to bits
Scalable
Memory layers can be stacked in a 3D manner
Breakthrough Material Advances
Compatible switch and memory cell materials
High Performance
Cell and array architecture that can switch states 1000x faster than NAND

This mighty memory solution might be the key to all our storage woes.

WHERE NEXT FOR SSDS?

A new kind of storage could change everything

Remember when the first mainstream solid-state drives popped up in 2008, and completely blew away traditional magnetic hard drives? Something similar looks to be on the cards for 2016.

That's right—there's a performance bomb heading the way of SSDs that could make existing drives look as outmoded as a magnetic hard drive. The big news is a new memory technology being jointly developed by Micron and Intel. Known as 3D Xpoint, it's not a souped-up version of an existing technology, such as RAM or NAND memory. It's completely new.

For starters, 3D Xpoint is claimed to be up to 1,000 times faster, 10 times denser, and 1,000 times more robust than existing flash memory. Needless to say, these are staggering numbers, and even Micron and Intel wouldn't claim they apply across the board. Indeed, when Intel demoed 3D Xpoint at IDF, the result was seven times faster IOPS performance than the conventional flash memory comparison drive. Still very impressive, but not quite 1,000 times faster.

As for how 3D Xpoint works, it's completely different from flash memory. Instead of having memory cells composed of gates in which electrons are trapped, 3D Xpoint is a resistance-based technology. Each cell stores its bit of data by changing the conductive resistance of the cell material. This also means that each cell does not require a transistor, which makes for smaller cells and higher density.

Meanwhile, the "3D" part of the name hints at the stacked or multi-layer aspect of 3D Xpoint. Early chips only have two layers, but further layers will be added as the technology matures. One final kicker for 3D Xpoint is the fact that memory cells are addressable at the individual bit level. That's a dramatic change from NAND memory, where whole blocks of memory—typically 16KB— have to be programmed to save just one bit of data.

The upshot for NAND is all kinds of read-modify-write shenanigans, and the need for complex garbage collection algorithms. That's all gone with 3D Xpoint. If that sounds wonderful, and it does, it's also worth bearing in mind that 3D Xpoint is so new and different, you can't just hook it into an existing SSD chipset and get going. All-new controllers and interfaces will be required. However, Intel has said it is prepping a new line of SSDs based on 3D Xpoint and known as Optane, and they are due out in 2016.

Where things get a little confusing is that it's not entirely clear where Intel and Micron see it sitting in the system. Some of their messaging has hinted at a new role that straddles system memory and mass storage, rather than replacing either. Likewise, Intel has said it is developing Optane-based memory DIMMs for Xeon server systems.

However you slice it, then, 3D Xpoint looks set to revolutionize storage performance in the PC, and it starts in 2016. What we don't know is how it fits in with the other big change going on in storage, namely PCI Express–based storage interfaces and the new SSD-friendly NVMe control protocol. At this stage, frankly, it's anyone's guess. But what we can say is that PCI Express and NVMe have come just in time. The idea of running 3D Xpoint over a crusty old SATA connection, limited to just 500-odd MB/s, when 3D Xpoint drives are likely to be capable of 5GB/s and beyond, is quite comical.

Next up on the storage list is likely wider adoption of those PCI Express interfaces in 2016. M.2 has already become a standard feature on a lot of motherboards. Thing is, M.2 is a somewhat fragile and fiddly format, based as it is on exposed circuit boards that plug into slots. Often, these are flush to the motherboard, which makes support for more M.2 drives tricky. They can be mounted vertically, but that makes for a somewhat fragile solution.

Instead, what's needed is a PCI Express storage interface for external drives. A little like SATA Express, then, but something the industry actually gets behind. Happily, such an interface has arrived, and it's called SF-8639. At least, it used to be called SF-8639, until somebody realized what an awful name that was and rebranded it U.2, to sit nicely next to M.2. Anyway, U.2 is the new standard for 2.5-inch drives connected via a cable, just like SATA drives, and it has all the PCI Express goodness of M.2. Look out for it in 2016.

POWERFUL, PORTABLE, STREAMABLE

Will the future of gaming be mobile?

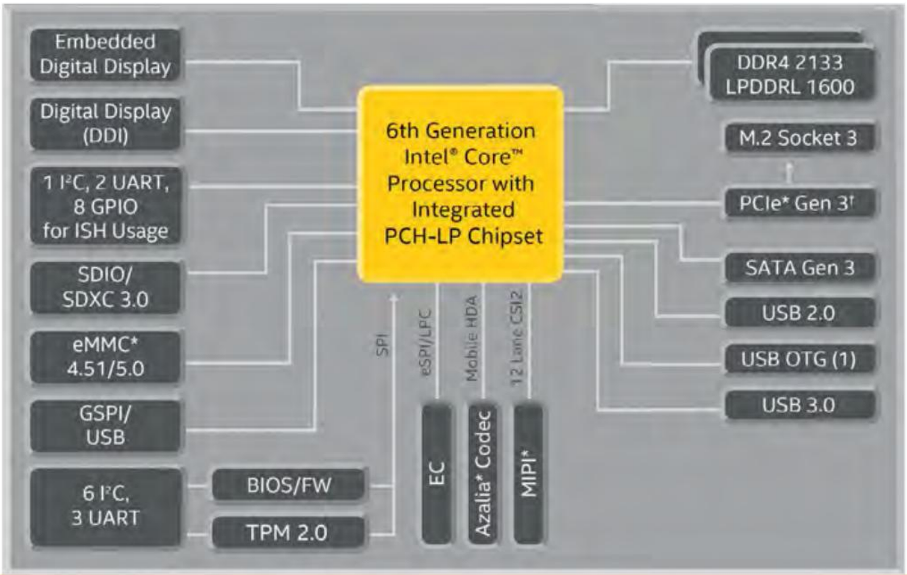
At the end of 2015, Nvidia announced the launch of the first full-fledged laptop graphics processor. A select range of signature gaming laptops from the likes of Asus, MSI, and Aorus, for the first time provided consumers with a fully unlocked GTX 980 GPU, featuring the same 2,048 CUDA cores, the same 256-bit memory bus, and the same 3GB of GDDR5 that the iconic desktop behemoth has to its name. To put that into context, whenever a discrete mobile GPU is created, it's essentially a stripped-back version of its desktop counterpart. However, unlike the GTX 980 Ti, which is technically a scaled-down version of the Titan X, these cores are often one step lower than their PC tower cousins. For example, a GTX 960 features a total of 1,024 CUDA cores, while its mobile equivalent only has a total of 640. It's this dramatic reduction in both power requirements and total heat output that helps ensure the GPU can run cool under pressure, without the need for a full-blown cooling system. Companies such as MSI and Alienware have made docking stations before, incorporating full-sized desktop GPUs, but they never had the same level of portability that a standard laptop had.

For the longest time, then, laptop users have been getting a pretty bum deal when it comes to graphical processing power. And with Pascal right around the corner, and Nvidia already taunting us with scarily high specs for its new GP104 and GP100 graphics processors, it's only a matter of time before we see these full-fledged cores make more of a mark in the mobile market. This is thanks in part to the reduced power requirements of the 14/16nm FinFETs that Pascal will be utilizing, on top of the additional performance. Perhaps next year we'll see Nvidia's first iteration of full-on GTX 1060s, 70s, and above inside gaming notebooks and ultrabooks, finally calling an end to the M line of graphics processors we've all come to despise trying to identify in these reviews.

As far as overall general processing power goes, Skylake will no doubt continue to dominate the market. Rumor has it that Intel will be launching a grand total of eight separate mobile processors during the first half of 2016. The high end will feature two i7s, two i5s, and two i3 CPUs, while the more entry-level notebooks will benefit from one Pentium and one Celeron processor. Taking a rather interesting step back, Intel has opted for all of them to operate on two cores, with Hyper-Threading enabled for a total of four threads, except the Celeron, aimed at the very budget end of computing. This is an interesting step back, as traditionally the top end of Intel's i7 mobile processors featured four cores and Hyper-Threading as well. All eight are set to operate around a 15W TDP. On top of that, you'll be guaranteed Intel's new HD500 series integrated graphics and DDR4 support. However, it's unlikely we'll see much of the new memory standard making its way into laptops just yet, as these mobile processors are still hanging on to DDR3L compatibility as well—much like its desktop cousins, a memory that has been the mainstay of laptops, thanks to its low energy requirements.

Of course, AMD will be cementing itself further into the office market with new fully dedicated SoC processors. With the announcement of the release of the new Merlin Falcon embedded processor, based on the Excavator architecture, it seems AMD is pushing for more industrial and commercial roles, such as communication and infrastructure. At the very least, this should provide the company with a solid and dependable revenue stream to keep developing its consumer line products going forward, with Zen launching some time in 2016.

Hyper-Threading for all!

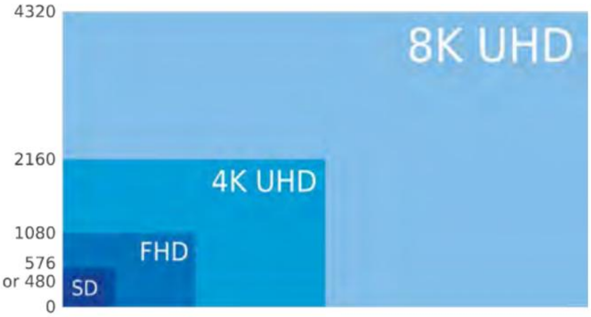


LIFE BEYOND 4K?

Coming to a screen near you: even more pixels

2015 was one heck of a year for PC monitors. It was the year 4K went mainstream. Ditto high-refresh 120Hz-plus technology. And frame-synching cleverness from both Nvidia and AMD. Oh, and we saw interesting new super-wide 34-inch panels. And curved screens, to boot. All the while, prices for established favorites like 27-inch 1440p IPS panels kept on falling. Nice. 2016 probably won't be quite as varied, but there's still plenty to look forward to.

In terms of technical innovation, quantum dot technology is looking pretty hot. It's not an entirely new display technology, along the lines of something like the ever-promising but never-quite-arriving-in-PC-monitors OLED technology. Instead, it's a new enhancement for existing LCD panels. Or rather, it's an enhancement for the backlight that powers all such displays.



Don't worry—it's only 33,177,600 pixels.

In simple terms—well, kind of simple at least—quantum dots are nanomaterials that convert light. Shine light on quantum dots and they absorb it, tweak it, and then kick out it out again. They're also highly tunable. The upshot is that you can use them to modify and much improve the quality of a cheap single-color LED backlight, and make it as good as—or even better than—an expensive RGB backlight. And that means more accurate and more vivid colors.

Philips launched the first quantum dot PC display in 2015, and you can expect an arm of QD monitors in 2016. Elsewhere, well, you can expect even more pixels. 4K is now affordable, 5K screens are available, and the pixel count is only going to go up. LG and other makers of LCD panels are tooling up for 8K displays. Yup, that's 7,680x4,320 pixels. Wow.

In fact, 8K HDTV sets are already available, and it's inevitable that PC monitors will follow suit. So 8K is odds-on for 2016. Just don't expect it to be cheap.

THE RISE OF THE STREAM MACHINES

2015 saw the launch of Nvidia's first venture into the living room, in the form of the Shield Android TV. Powered by Nvidia's own Tegra X1 processor, featuring a 256-core GPU and 3GB of RAM, it's by far the most powerful streaming device out there to date. Then factor in its insanely low price point of just $200, coupled with 1080p 60fps gaming, and you've got yourself a powerful living room streaming platform, capable of taking on any console at a fraction of the cost. At least, as long as you have the bandwidth to spare, of course.

Nvidia's intention has been to bring the PC experience to those mobile gamers who are after something more, but are still unwilling to commit to the cost of either a console or a dedicated gaming PC. In 2016, we should see that 1080p 60fps expand up to 4K 60fps, currently in beta, again bandwidth permitting. The true test for the little box of joy will be whether it can decompress that data fast enough to provide a lag-free gaming experience.

On top of that, the launch of Steam OS in November has provided many with a tangible exit from the Microsoft ecosystem, alongside an interesting new way of gaming. Companies such as Zotac and Alienware have brought out custom Steam boxes, with many case manufacturers also designing chassis specifically for the new style of systems. The idea is pretty simple: PC gaming in your living room. Either through a prebuilt system, such as Alienware's Alpha Steam Machine, or through your own custom build.

If you're still not entirely taken by Steam OS, there is one other perk: With Steam's support and close links to Linux, it's inevitable that a far greater number of Steam games will also now start to come with Linux support. Meaning our brothers across the OS pond will finally be able to game alongside us.

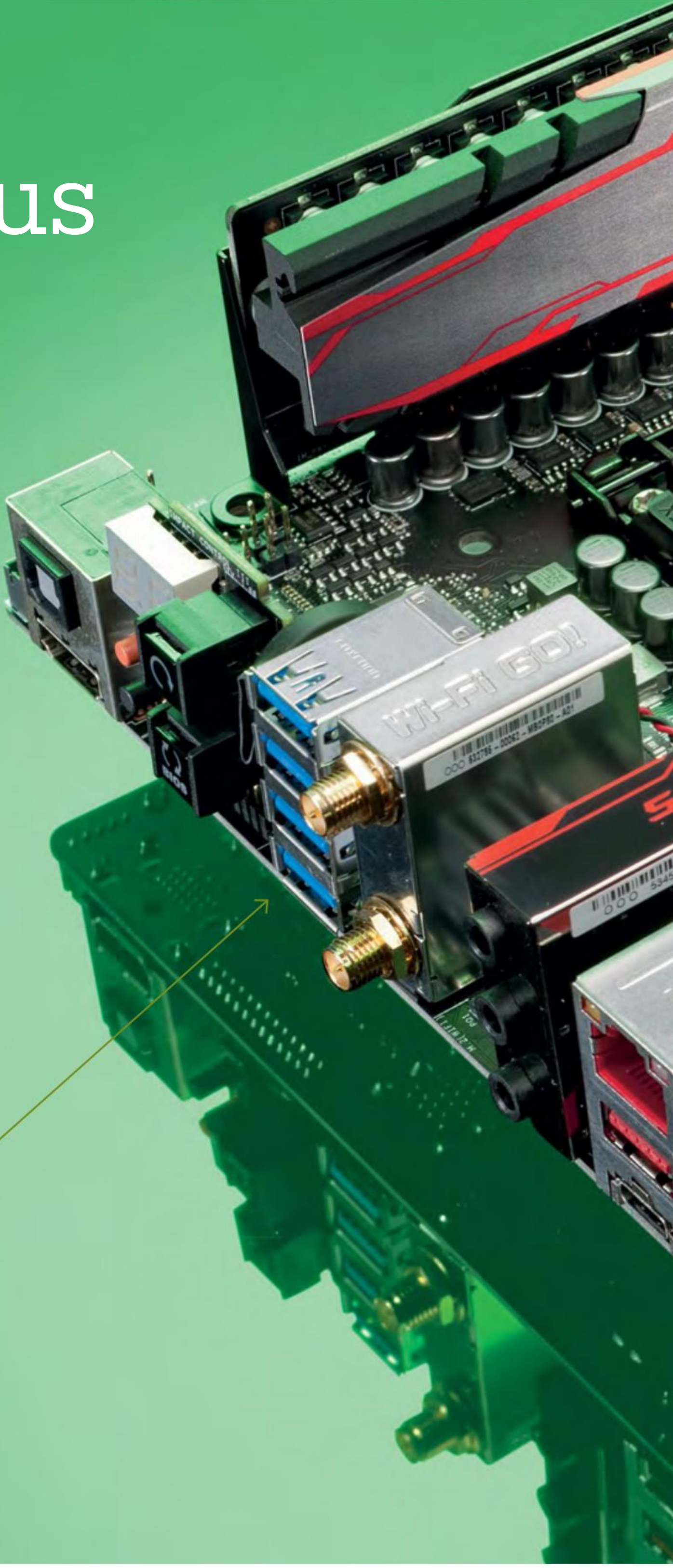
Syber Vapori, the Steam-branded machine.

TECH PORN

Asus Maximus VIII Impact

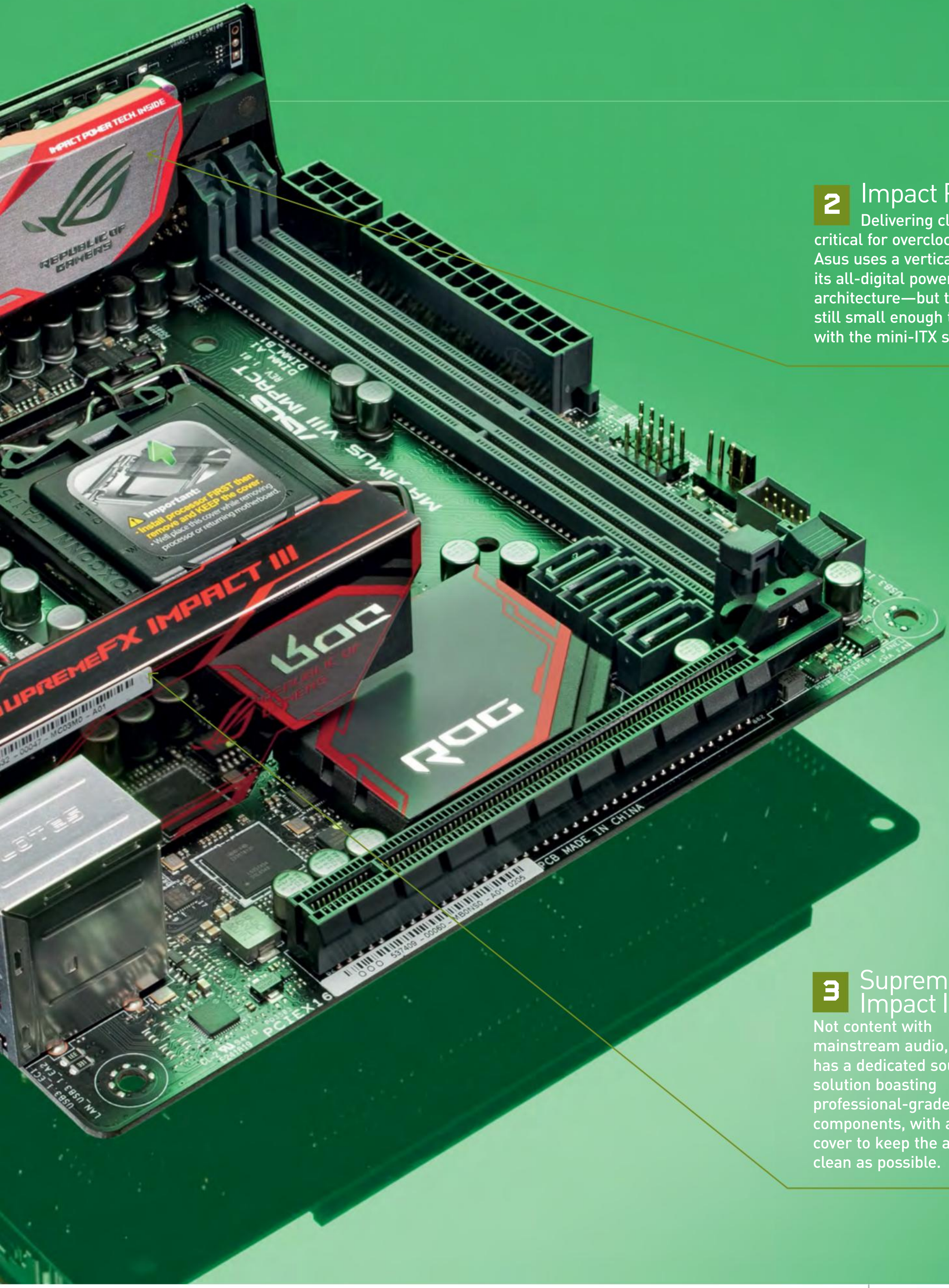
NOT EVERYONE NEEDS A GIANT full-size tower sitting under their desk, but just because you want a smaller system doesn't mean you have to compromise on performance or quality. Mini-ITX motherboards have been gaining in popularity and features, and with the launch of Skylake, we're seeing tiny mobos that can give the big boys some much-needed competition. The Asus Maximus VIII Impact may not be the smallest board on the block, but it packs some serious firepower.

Take the features list, which includes 802.11ac Wi-Fi with Mu-MIMO, USB 3.1 Type-A and Type-C connectors (plus support for up to six more USB 3.0 ports), four SATA ports, x16 PCIe slot, SupremeFX Impact III audio (ES9023P DAC), onboard debug LED, Z170 chipset with CPU overclocking support, and DDR4 speeds up to 4,133MHz-plus. About the only item missing from that list is an M.2 slot, but Asus has that covered as well with a U.2 connector with NVMe support. –**JARRED WALTON**



1 A Plethora of Ports

Asus packs a ton of options into its I/O area, including a debug LED, reset and BIOS clear switches, and Wi-Fi. There's no DisplayPort output, however, so if you're using the CPU graphics, you're limited to an HDMI connection.



2 Impact Power III

Delivering clean power is critical for overclocking, and Asus uses a vertical board for its all-digital power delivery architecture—but the board is still small enough to conform with the mini-ITX standard.

3 SupremeFX Impact III

Not content with mainstream audio, Asus has a dedicated sound solution boasting professional-grade components, with an EMI cover to keep the audio as clean as possible.

THE STORIES

How modern games are offering a whole new spin on narrative *by Richard Cobbett*

Many years ago, the very smart John Carmack said a very silly thing: "Story in a game is like a story in a porn movie. It's expected to be there, but it's not that important." That hasn't really been true since games set their sights higher than "save the princess" and "defeat the aliens." In recent years, though, story has been on the rise. The adventure and RPG genres have seen a resurgence, thanks to games like *The Walking Dead* and *Dragon Age*. In *Mass Effect,* give or take one terrible ending, BioWare created one of the finest interactive SF universes in any genre. From indie games to *Tomb Raider* to *Grand Theft Auto,* the modern industry badly wants to tell stories.

Looking in, that can seem strange. With all due respect to most games and their hard-working developers, the average game story isn't exactly Shakespeare—if we discount the fact that prior to his plays' appearance in stuffy English Literature lessons, they were largely the disposable, popularist entertainment of the time, and therefore actually not a bad comparison at all. And the members of his troupe appreciated the role of the writer. That doesn't mean they can't be effective, and to a large extent just watching or describing what happens does them little justice. The fact that they're interactive, intimate, responsive, that we get to be the stars instead of just passive onlookers, can't be overestimated, any more than a roller coaster can be appreciated from the sidelines, or a movie has the same power when committed to paper instead of blown up on a big screen with an orchestral soundtrack, and the gasps and laughs of an appreciative audience. Games aren't just a new way of telling stories, but a unique one. In the '90s, much money was wasted trying to ape Hollywood. Now, the focus is on what games can do that nobody else can—a far more interesting question, with infinitely more potential.

But story isn't simply about what happens, but a catch-all term that encompasses much of the experience. A world can tell a story, or simply contribute to one. Take *Bioshock Infinite*'s Hall of Heroes. Its mechanical function is for main character Booker deWitt to get a bottle of magic jollup that lets him throw lightning bolts, as well as having a boss fight. Its real purpose, though, is to offer perspective on the flying city of Columbia and its racist politics—how the Battle of Wounded Knee is presented as a great triumph rather than a national disgrace, and how villain Zachary Comstock has weaponized history by rewriting it in his favor, in a similar way to his co-opting of the Founding Fathers as avatars of his twisted religion. It's all stuff that could be, and often is, covered by dialogue, but by showing instead of just telling—by allowing us to get hands-on with it and explore it at will—it becomes meaningful. It becomes real.

Elsewhere, more subtly, the story of whole areas is told by their architecture—the contrast of business district Fink Manufacturing to the shanty towns around it; the giant clock that rewrites time as Work and Spiritual Duty, with a tiny scrap of time for Sleep; the demonstration of Fink's ego as manifest in his own offices; and nods to religious expectations. *Bioshock Infinite*'s tale of other dimensions can get bogged down in SF jargon, but as a place, it has no parallel. To paraphrase the *Superman* movie, you believe a city can fly.

THE STORY OF WORLDS

Games are the only storytelling medium that can fully take advantage of this kind of narrative—blockbuster vistas, yes, often, but the camera free to explore and savor the detail instead of just filming it as it shoots past. They can unchain the player from the direct action and allow sight-seeing, vignettes that dig deeper, and mechanics that reinforce a game's themes.

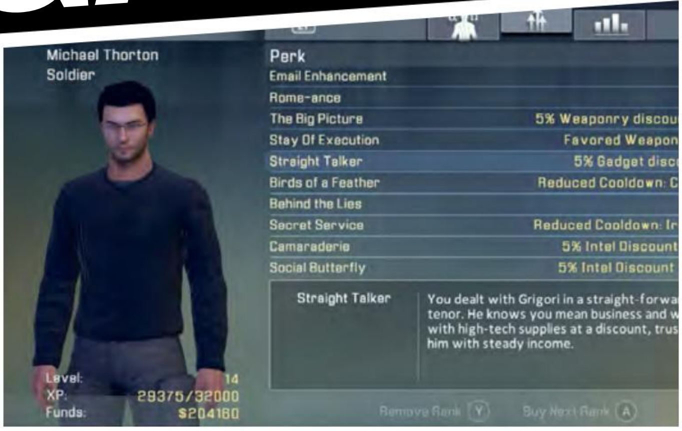
The Walking Dead, for instance, has your group of survivors starving as they hide from the zombie menace—your character, Lee, in charge of divvying out the last of the food. Pragmatically, it doesn't really matter who you give it to, but that's beside the point. Having to choose puts you into the mind of someone faced with that awful decision—to balance fairness with need, to focus on the kids of the group instead of the adults, to pick at random, or simply to stuff all of it into your mouth just to see what happens. No other form of storytelling allows for not simply that choice, but for ownership and complicity in what happens as a result. This is especially pointed when you're pushed into the position of crushing dreams, hurting the innocent, or making bad things happen to good people—acts that can be surprisingly painful, even knowing they're not real.

BY THE GENRES

Adventures and RPGs have always been the ambassadors for storytelling. Adventures have a library of classics like *The Last Express, The Longest Journey, Grim Fandango,* and *A Mind Forever Voyaging,* a text adventure that was pretty much the first "walking simulator," in which you play a sentient computer visiting simulations of the future to foil a political movement that will lead America to destruction. You don't need to look far to find an RPG with more of an eye on plot than loot, from the philosophically rich *Planescape Torment* based on the question "What can change the nature of a man?" to *Ultima,* a series spanning a decade of questions about morality and humanist social upheaval.

It makes sense that they'd have this history, not only with a focus on story but specific mechanics like dialogue trees to help interact with the world. Other genres spent years without

GAMES TELL



Michael Thorton
Soldier

Perk	
Email Enhancement	
Rome-ance	
The Big Picture	5% Weaponry discou
Stay Of Execution	Favored Weapon
Straight Talker	5% Gadget disc
Birds of a Feather	Reduced Cooldown: C
Behind the Lies	
Secret Service	Reduced Cooldown: Ir
Camaraderie	5% Intel Discount
Social Butterfly	5% Intel Discount

Straight Talker

You dealt with Grigori in a straight-forwa tenor. He knows you mean business and w with high-tech supplies at a discount, trus him with steady income.

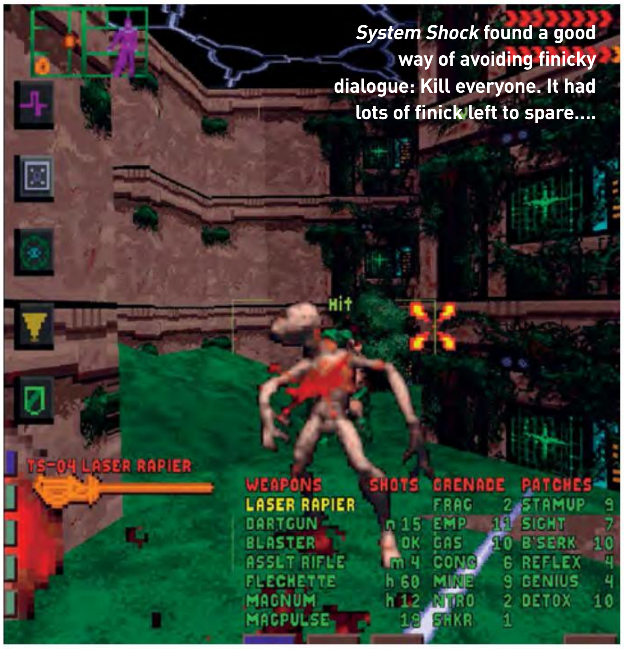
Level: 14
XP: 29375/32000
Funds: $204160

Remove Rank Y
Buy Next Rank A

Alpha Protocol even tracks how many orphans you leave, by national average.

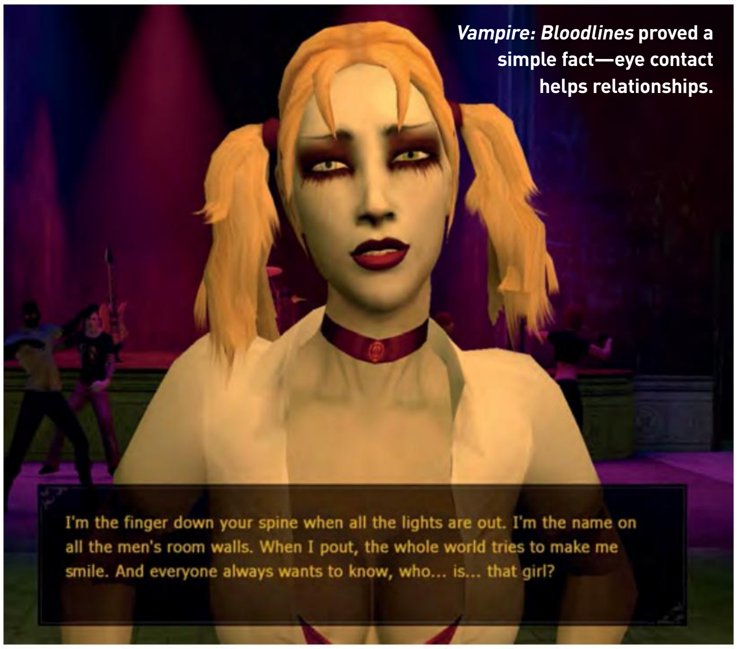
Bioshock 2 and *Bioshock Infinite* both rely on making the player care about a girl.

MOTHER MARY
SHE LIVED TO PUNISH MEN
EMPLOYEES ONLY



System Shock found a good way of avoiding finicky dialogue: Kill everyone. It had lots of finick left to spare....

WEAPONS	SHOTS	GRENADE		PATCHES	
LASER RAPIER		FRAG	2	STAMUP	9
DARTGUN	n 15	EMP	11	SIGHT	7
BLASTER	OK	GAS	10	B'SERK	10
ASSLT RIFLE	m 4	CONC	6	REFLEX	4
FLECHETTE	h 60	MINE	9	GENIUS	4
MAGNUM	h 12	NTRO	2	DETOX	10
MAGPULSE	19	SHKR	1		



Vampire: Bloodlines proved a simple fact—eye contact helps relationships.

I'm the finger down your spine when all the lights are out. I'm the name on all the men's room walls. When I pout, the whole world tries to make me smile. And everyone always wants to know, who... is... that girl?

the tools to really tell stories, with the exception of rendered cut-scenes, mission briefings, and such, and only a few able to break out of that to do something different. *Wing Commander,* for instance, was a pioneer, looking to simulate the action on board a carrier during a space war, instead of just the cockpit action, complete with medal ceremonies and meeting pilots in the pub. *Wing Commander III,* the most expensive game ever at the time, not only did this in FMV, which admittedly hasn't aged well, but dared to do it with a downright depressing story of failure and betrayal, far from the ra-ra blockbuster style it was attempting to emulate on the small screen.

For other genres, new ideas were needed to make things work. For example, *System Shock,* a hybrid RPG/shooter, pioneered the audio log method of storytelling, in which you find people's diaries conveniently scattered everywhere, solely because the developers couldn't think of an immersive way to handle dialogue. It was a clever idea, though its continued use has become something of a crutch. (Hopefully, the ruthless parody of the style in *South Park: The Stick of Truth* has helped to take that crutch and beat the idea to death with it.)

BEYOND ADVENTURE

Generally, though, most genres have moved into story in the same way—look at adventures and RPGs, borrow their tricks, then start inventing new ones. *Strife,* for instance, an obscure shooter using the *Doom* engine, added dialogue and quest systems, but also some advanced features, such as a world built around a hub that changed during the game. At the start, the villains rule from a castle. By the halfway point, you take it over and it becomes your base of operations for the rest of the game—a huge feeling of accomplishment. *Grand Theft Auto* began by just having canned missions, before expanding out to wider world simulation elements and spin-offs, such as optional missions, territory control *(Vice City),* and dating *(San Andreas),* before spinning out into *LA Noire* with its investigations, and attempting to recreate a real city instead of just the flavor of one.

Often, the big push can come from the strangest places—as long as they're successful. Action adventure games were largely put on the path by *Metal Gear Solid,* which showed that you could tell a deep and interesting story within the constraints of something as simple as stealth. For the FPS, the sea change was *Half-Life 2,* which didn't create but did popularize the theme park ride style of the genre—setpiece to setpiece to setpiece. It wasn't until 2007's *Call of Duty 4,* though, that the story rather than the storytelling really came to the fore, adding the human side to warfare—in particular, playing as a soldier dying in the aftermath of a nuclear explosion,

***The Walking Dead* gave adventures a much-needed shot in the arm, and made choice an expectation rather than a feature.**

OPEN WORLD ADVENTURES

From *GTA* to *Assassin's Creed,* games can do open worlds. It's time to do more with them now.

IT'S EASY to tell a good story when the player is on a leash. Open worlds are infinitely harder, especially when the player has the raw power that tends to come with them—driving around in a tank in *GTA,* being a god of destruction in *Metal Gear Solid V,* and so on.

This is the next big frontier, though one that few are ready for. Even *GTA V* draws a sharp line between messing about in the city and the serious business of scripted missions, where your freedom goes out of the window in favor of "Go HERE, in THAT car, and shoot THAT guy with THIS gun." Its more light-hearted rival *Saints Row* gets around it by just making everything chaotic, but again, the story suffers. It works if all you need are the characters riffing, but that's all. Elsewhere, we've all probably played a game like *Assassin's Creed,* and been disappointed to see a city such as London or Paris used for just canned parkour chases and collection quests.

The challenge is to combine open world's joys—being able to create your own stories—with a world whose scripts and systems make your choices meaningful and grounded in interesting characters and results. For instance, there's no reason a *GTA* game couldn't be about territory control, with missions and characters being triggered by your actions. You keep attacking one side, their assassins start turning up, and eventually you get a meeting with their leader.

The catch is that right now, developers are terrified of letting players end up in too bad a situation, so either you get roguelikes/RPGs such as *Sunless Sea,* where death is only one mistake away, or dedicated RPGs where nothing you do truly matters.

Still, the potential is there. The tiny pushes toward this in existing games show both that, and how far there is to go. *Metal Gear Solid V*'s base building and army customization; *The Witcher 3*'s careful mix of exploration and scripted missions; *Skyrim*'s stock quests and Radiant AI–generated ones; and on console, the original *Crackdown*'s willingness to just give you a city and targets. The next generation of open worlds wants to do better. And it absolutely can.

Is *Gone Home* a game? There are a thousand angry threads if you want to fight about it.

THE WORLD OF WALKING SIMULATORS

WE NEED A NEW way to describe this burgeoning genre, without the sneer. "Experience games," perhaps. Whatever you call them, they started out self-consciously arty with the likes of *Dear Esther,* and do occasionally flit too far that way in pretending to be about more than they are—*Ether One*'s look at dementia and *Among The Sleep*'s attempt to show an abusive maternal relationship both stand out as importance bolted on to surrealism. But, when they work, they can be amazing—*The Stanley Parable*'s humor, for instance, spoofing and playing with 3D genre conventions. *Gone Home,* which both tells a touching romance and acts as a '90s time machine for those fond of the genre. *The Beginner's Guide,* a personal story about game development. *Submerged,* about exploring a surreal flooded city. *Sunset,* in which your role as a cleaner to an important man in a revolution explores power from the point of view of the powerless. *The Vanishing of Ethan Carter,* drawing horror from the surreal and familiar. Most recently, *The Park,* a *The Secret World* tie-in that rebuilds one of its locations as the setting for a mother searching for a lost child in a world full of *Hansel and Gretel* references.

It's not a genre that everyone is going to appreciate—though there's rarely that much less freedom than in the average shooter these days. Often, there's more, as there isn't the need to push players from corridor to corridor. A related genre borrows from *Portal* to tell stories through other means, usually puzzles. *Magrunner,* for instance, doesn't worry too much about everything being an overt test, but uses it to go from sterile labs to *Cthulhu*-style horror. More recently, *The Talos Principle* combined block and laser puzzles with oddly deep philosophy. Generally, these are short games, costing about the same as a movie ticket. It's best to think of them in those terms rather than compare them to something like the 50 hours of another game, or the 10 hours of action elsewhere. If they're not for you, that's fine. If they are, the success of recent ones such as *The Stanley Parable* mean that there are going to be quite a few more on the way.

the dispassionate nature of bombers high above the battlefield, and an intimate sortie into Chernobyl. The effectiveness of these scenes, combined with *Call of Duty*'s insane sales figures, confirmed that shooters offered interesting ways to tell stories without being propped up by RPG elements.

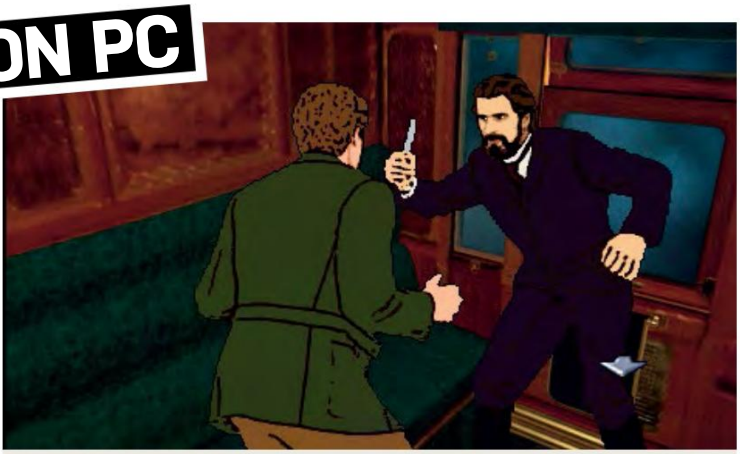
This, of course, led to the mixed success of *Spec Ops: The Line*—a mediocre shooter in terms of raw mechanics, but a brave and deservedly cult hit that toyed with everything from the degradation of its main characters' psyches (early AI barks being professional military talk, descending into gutteral "****ING SHOOT HIM!" level as the game goes on), playing a hero whose weakness turns him into the villain, without him ever realizing, and some shocking individual scenes. The main one involves deploying a white phosphorus attack on what turns out to be civilians, with Spec Ops then forcing you to walk through the frozen agony of the victims in a way that breaks the main character's mind and sets him on his path to damnation.

One of its most effective techniques, though, is like many modern games: how it handles choice. Mostly, you're on a rail, with one of its biggest problems being that deploying the white phosphorus is a forced act—if you don't want to, or you see what the protagonist doesn't and try to avoid it, you're not allowed to progress, and the intended sense of complicity is lost.

But on a smaller scale it did some very interesting things—one of the biggest being when you get surrounded by some very justifiably angry civilians, who your actions have likely condemned to a painful death by thirst. You are mobbed. You have a gun. If you start shooting, everyone flees. There's nothing, however, stopping you from shooting your gun into the air instead—it has the same effect, but nobody dies. It's a stark reminder of why good people don't necessarily do the "right" thing under pressure, as well as a rare chance to get into the

THE BEST STORIES ON PC

PLANESCAPE TORMENT
What can change the nature of a man? How about a trip through a surreal multiverse where belief shapes reality? Its high point is arguably a quest to learn magic that fools you into thinking you're just doing pointless fetch quests, before asking, "Now what did you learn?" The rest is a dark, funny, sad, often brutal adventure.

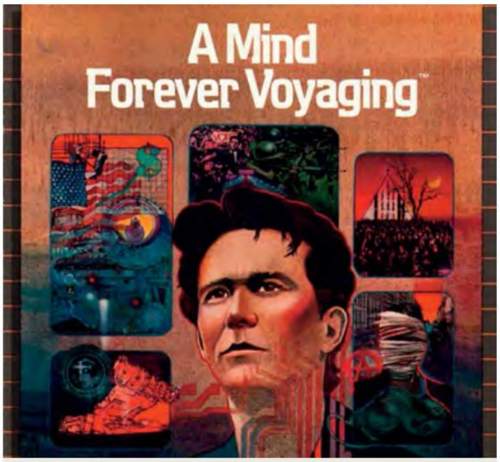


THE LAST EXPRESS
It's the eve of World War 1, and the Orient Express is setting out from Paris to Constantinople. It leaves with passengers. It arrives with survivors. An amazing real-time adventure that treats the locomotive as a microcosm of the European powers, where you explore the train to discover its secrets before anyone learns yours—one that you as the player are also in the dark about.

BIOSHOCK INFINITE
Not everyone loves the parallel world side of *Bioshock*, but the city—the cities, with the Burial At Sea DLC—are simply amazing, and the relationship between hero Booker and his charge Elizabeth deservedly made *Bioshock Infinite* a beloved game. Pity about the terrible combat, and too often being rushed past the best stuff by an army of fireball-throwing racists.

HOT DOGS
DELICATESSEN

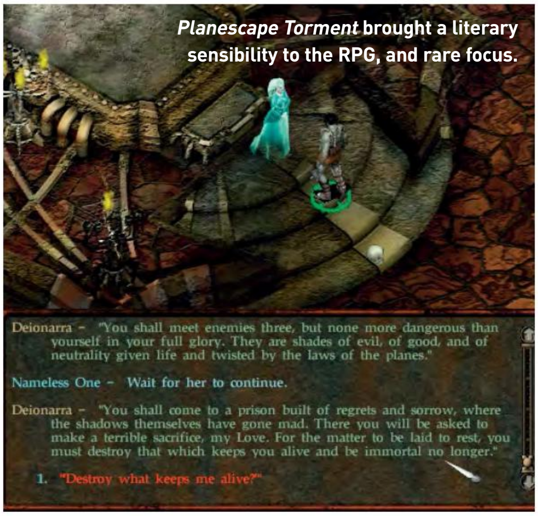
MASS EFFECT
BioWare's sci-fi universe may walk well-trodden paths in its main story, but the characters make this trilogy a true classic. Just try to hold back the tears in the final DLC, Citadel, when the cast prepares for the end and BioWare says goodbye—Commander Shepard and the battle-hardened team stare at their ship and he comments, "It's been a hell of a ride." "The best," they agree.



A MIND FOREVER VOYAGING
This used text to paint its world—several decades of a collapsing America, seen by simulation. It worked because much of the effect was shown on your family and friends; all simulated, but no less real to the main character—a sentient computer.

Wing Commander III hasn't aged well but it's still an ambitious story.

Doom may look simple, but did you know there are four novels about it? Really.



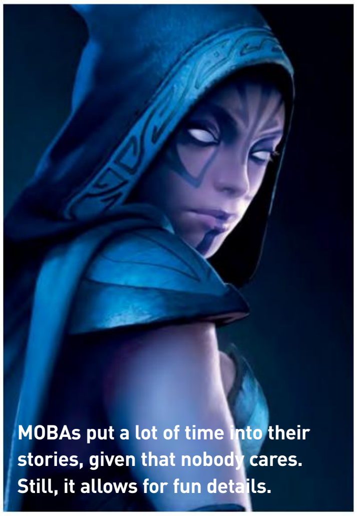
Planescape Torment brought a literary sensibility to the RPG, and rare focus.

Deionarra – "You shall meet enemies three, but none more dangerous than yourself in your full glory. They are shades of evil, of good, and of neutrality given life and twisted by the laws of the planes."

Nameless One – Wait for her to continue.

Deionarra – "You shall come to a prison built of regrets and sorrow, where the shadows themselves have gone mad. There you will be asked to make a terrible sacrifice, my Love. For the matter to be laid to rest, you must destroy that which keeps you alive and be immortal no longer."

1. "Destroy what keeps me alive?"



MOBAs put a lot of time into their stories, given that nobody cares. Still, it allows for fun details.

Too much focus on personal quests has seen the "MMO" bit of MMOs fading into nothingness.

mind of someone making an unjustifiable decision.

CHOICE AND CONSEQUENCE

Choice, especially with a sting, is one of the most powerful weapons games have. It's often misunderstood, especially in scope—classically, it's been a good/evil split that determines which ending you get. More recently, games have bent over backward to tell us that our choices count. Telltale Games is particularly guilty of this, using the same smoke and mirrors for each of its games. Only a few have really embraced it, with the prize going to Obsidian's *Alpha Protocol*—an insane web of decisions, characters, and relationships so complex that it factors in people being pleased that you visited them first in town, and bosses you may never meet.

Generally, the idea isn't to create a game that rewards replay, but to make the all-important first playthrough adapt around you—to let you say what you want, to give you a sense of power, even if the core plot is locked down, to make decisions more meaningful by having characters respond, and to encourage you to think about what you do. The smartest thing in *The Walking Dead* was the phrase, "Clementine will remember that"—its story arc being only partly about survival, and more about preparing her for the dangers ahead. *Bioshock 2* offered something similar with Eleanor, a grown-up "Little Sister" and daughter surrogate, who learns her morality by watching your actions—your mercy, restraint, cruelty, and avarice all shaping the woman who finally leaves the underwater city of Rapture to bring its terrors and technology to the surface.

Incidentally, these games also began a trend of games mocked as the "daddification of games"—*The Last of Us, Bioshock Infinite, Dishonored, Heavy Rain,* and others focus on the experience of a father looking after a child, in a theme it's hard not to see as part of a largely male creative workforce getting older.

Traditionally, choice is picking from a series of options. It's the easiest way. With the rise of open worlds, and games allowing for heavy customization (crafting, costumes, and so on), more choices become available. *Metal Gear Solid V* is far less story-driven than earlier games in the series, being focused on open worlds and those darn audio logs.

At the same time, more than it initially seems, it merges with a more personal narrative—the one you create for yourself. Is your Venom Snake going to be a ruthless monster, who ends up looking like a literal demon with blood that never washes off, or more pragmatic? Do you trust characters like Quiet, the underdressed sniper, or put a bullet in her face? When this approach works, story becomes more than just being sat down and told one. It's collaborative, where the developer sets a stage and a framework, and provides a cast, but the player fills the action with comedy and meaning.

This isn't the same as dropping the player into a world and telling them to make up their own story, but giving them the tools to make its parts more than just pixels and polygons. There's no processor more powerful than the brain, nor any friendship or loyalty more important than those we choose. Now that a game recreating reality is no big thing, the obvious next step for almost every genre is to dig a little deeper and make that recreation meaningful. From story to worlds to plot, the future of gaming is the future of story. It's an untapped field ready to give us amazing experiences that nothing else can come close to, regardless of whether we choose to interact with them using words, guns, and shovels, or simply sit back and enjoy the ride. ⏻

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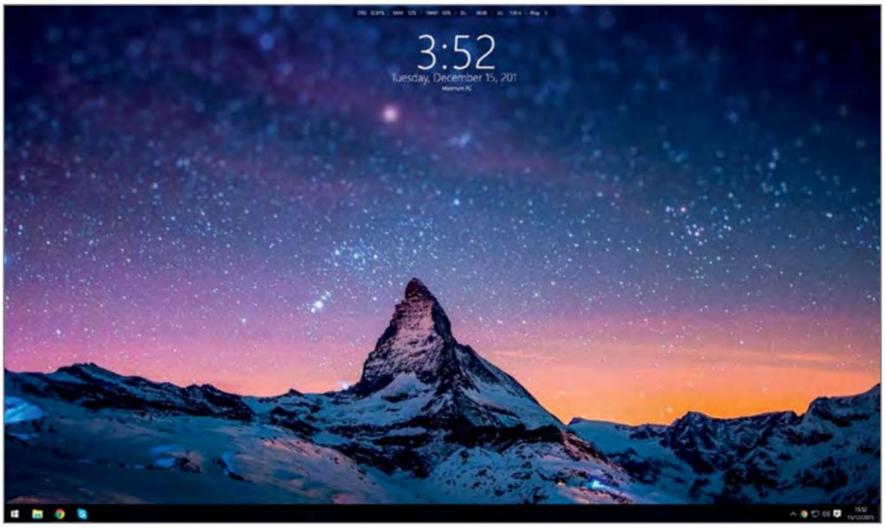
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH



JAZZ UP YOUR DESKTOP WITH RAINMETER

Bored with the basic desktop setup? Want something more vibrant and useful? Well, a quick and easy solution is the nifty Rainmeter, which adds useful widgets to your desktop. You can enable hyperlinks, search boxes, clocks, weather, RSS feeds, music players, you name it. To install the base program, head to www.rainmeter.net and if you're looking for skins, try Deviant Art's Rainmeter section at http://bit.ly/MPCRMSkins.

MAKE – USE – CREATE

60
Stream music with the Raspberry Pi

66
Extreme audio editing with RX 5

68
Well red—build an AMD-based ruby rig

ZAK STOREY
STAFF WRITER

THANKS, WINDOWS 8

Now, I know what you're thinking: What on earth are you talking about Windows 8 for? But, honestly, if we ignore the massive argument currently going on between the Windows 7 users on one side and the Windows 10 converts on the other, it's about time we appreciated a very special feature that made its way into that fateful, awkward-child OS. The same feature that has stayed with us into the new dawn that is Windows 10.

I'm talking about the ever-faithful, historical Task Manager. Otherwise known as Ctrl-Alt-Delete. That useful button combo has provided millions with a quick and easy way to deal with many a crashed program or operating system error in the past. It certainly cemented my rise to IT nerd stardom in elementary school, after showing teachers how to effectively get out of a program in Windows 2000 (yes, I'm that young).

What's so good about it? Well, the simple version keeps your grandma happy—she can find the program that's gone wrong and hit "End Task," fair enough. But for us pros, if we hit the "More details" arrow at the bottom, there's a world of figures and stats awaiting us. Most notably the "Performance" section. Really, here I'm talking about overclocking. If you're looking for a quick and dirty indicator of what frequency your CPU is running at, and how much load your system is under, look no further.

↘ submit your How To project idea to: comments@maximumpc.com

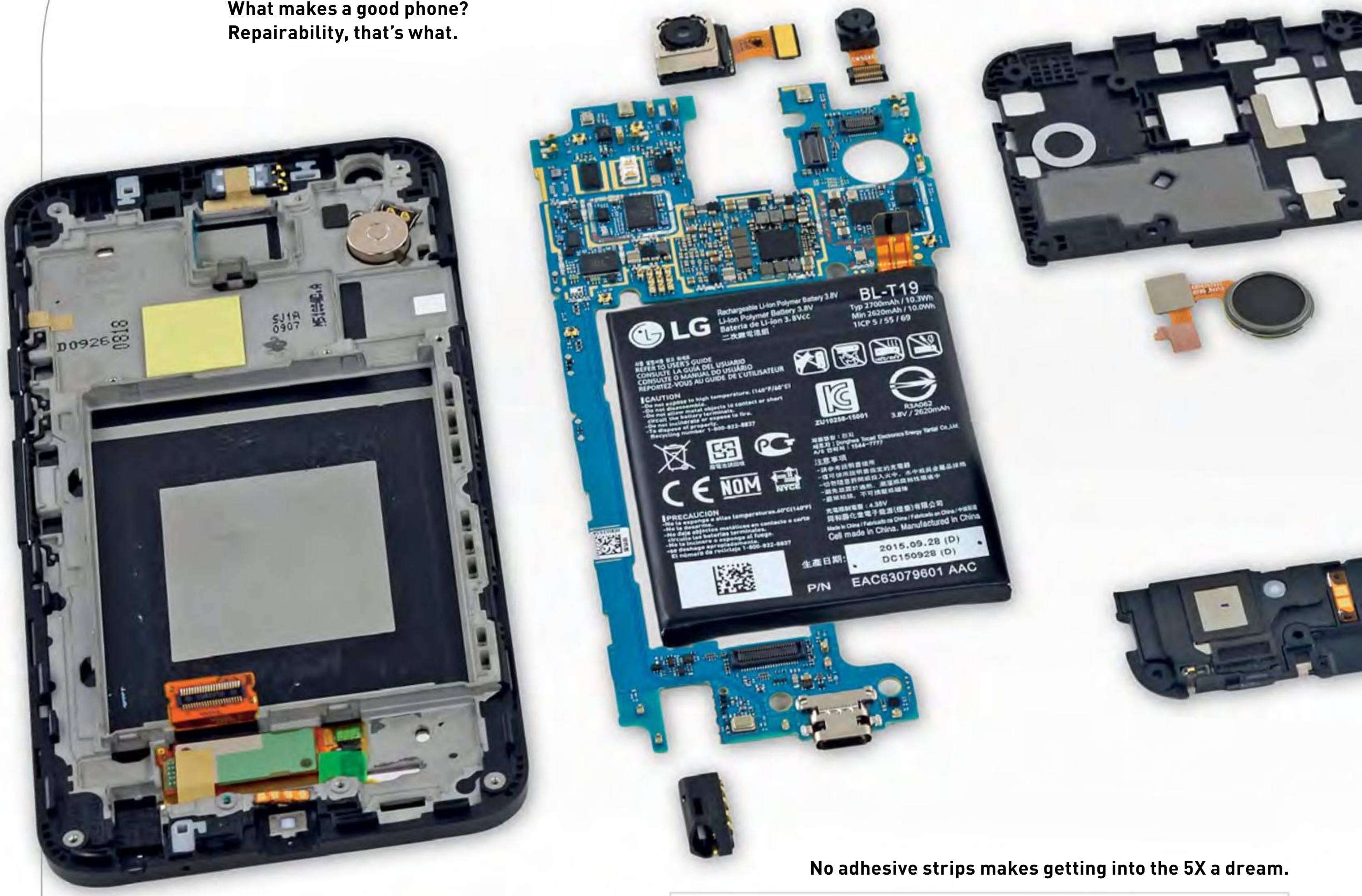
IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Nexus 5X

What makes a good phone? Repairability, that's what.



No adhesive strips makes getting into the 5X a dream.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

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All the screws are Phillips heads—thanks LG!

BACKGROUND:

It's been a couple of years since Google unveiled its last 5-inch smartphone, the Nexus 5, and a lot has changed since then. One thing remains constant, though—we're still tearing down Nexuses as fast as they (in this case, LG) can make them! Today, we're looking at the Nexus 5X. Will the 5X earn the same high marks? Join us round the teardown table as we find out!

MAJOR TECH SPECS:

- 1.8GHz Qualcomm Snapdragon 808 hexa-core 64-bit processor with Adreno 418 GPU and Android Sensor Hub
- 12.3MP/4K rear camera with laser-assisted autofocus, and 5MP front-facing camera
- 2GB LPDDR3 RAM with 16GB or 32GB internal storage
- 5.2-inch full HD 1920x1080 IPS LCD at 423ppi
- USB Type-C port with support for fast charging
- Nexus Imprint fingerprint scanner
- Android 6.0 Marshmallow

KEY FINDINGS:

- Google's latest Nexus sports a reversible USB-C charging port alongside the headphone jack. However, despite the fancy new look, it only supports USB 2.0 transfer speeds—like the OnePlus 2. Bummer. What's not a bummer is the increased charging speed (5V/3A) the USB-C port provides.
- Just like its older sibling, the 5X uses clips to secure the rear case to the rest of the phone. The similarities end there, however, as the adhesive strips found on the Nexus 5's rear case are nowhere to be found in the Nexus 5X. LG seems to have gotten the message about our feelings on adhesive.
- Our spirits soared as we spied the 2,700mAh battery sitting in plain view—a removable battery is hard to come by these days. Some light adhesive secures the battery, but it's nothing that a little spudgering can't handle.
- Piggybacking on the midframe is the Imprint fingerprint reader. Google claims it can recognize a fingerprint in just 600ms—quick enough to skip the lock screen entirely. Flipping the Imprint over reveals an unidentified control chip and our favorite—spring contacts! These are much more durable than traditional connectors that snap into place, and they're much easier to work with during repairs. Win win!
- Similar to the LG G4, the USB-C port is soldered to the motherboard. Unless you know how to microsolder, you'll need to replace the motherboard if the port fails.
- Repairability Score: 7 out of 10 (10 is easiest to repair). Many components are modular and can be replaced independently. Standard Phillips screws mean a driver is easy to find. The battery isn't immediately accessible but isn't too challenging, or too adhered, to replace. Fused display assembly—glass and LCD need to be replaced together if either breaks.

Stream Music with the Raspberry Pi

YOU'LL NEED THIS

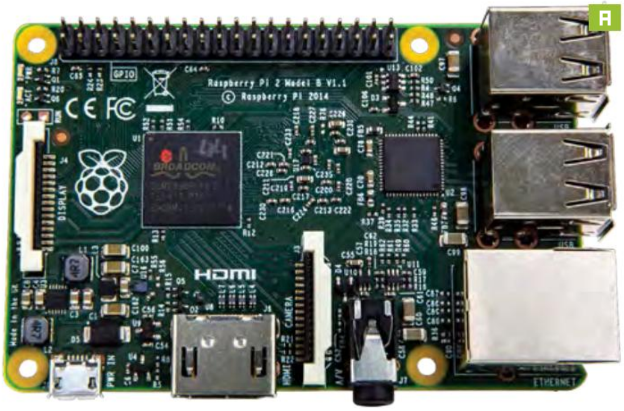
RASPBERRY Pi 2
The brilliant mini-computer costs under $45. See www.raspberrypi.org.

PI MUSICBOX DISTRO
Download it from www.pimusicbox.com.

WE'VE GOT MUSIC EVERYWHERE. In addition to DRM-free tracks on your hard disk, you've probably got hundreds of tracks on Spotify or Google Play. You can bring them all together with the Pi MusicBox distro, which transforms the Raspberry Pi into the ultimate music player.

The secret sauce that powers Pi MusicBox is the Mopidy music server, which can fetch music from a variety of sources. The distro couples its powerful underpinnings with a nicely designed browser-based user interface to control playback, and configure other aspects of the distro.

In Pi MusicBox, you get a headless media server that can play music from a variety of sources, in all the popular audio formats, from a connected USB or a NAS device, as well as streaming internet radio. The distro is designed for audiophiles and is fully equipped to work with your hi-fi gear. It can output music through speakers attached to the headphone jack of the Pi, and also through the HDMI and USB ports. So all you have to do is install the distro, hook up some speakers to the Pi, plug in your account credentials, and let it rip. You can then control your juiced-up Pi from any computer on the network and even from any Android device. –**MAYANK SHARMA**



1 DOWNLOAD PI MUSICBOX

Begin by downloading the compressed image for the Pi MusicBox distro from www.pimusicbox.com. Extract the downloaded ZIP file, and then put the IMG image file on your SD card with the "dd" command, such as:

```
$ sudo dd if=musicbox0.6.img of=/dev/sdd
```

Remember to replace "/d/ev/sdd" with the location of your SD card.

» If you use the Ethernet port to connect the Pi to the internet, you can boot the Pi from the newly-created SD card [Image A]. However, if you use a wireless card, you need to edit the distro's configuration file and manually point it to your wireless router. Access the newly-created SD card from a regular distro, navigate to the config/ folder, and open the settings.ini file in a text editor. Near the top you will notice two variables: "WIFI_NETWORK" and "WIFI_PASSWORD." Insert the corresponding values of your network next to these two variables, and save the file. The caveat is that Pi MusicBox only works with WPA2-protected wireless networks.

» Once that's done, boot the Pi with the configured SD card. If you have a monitor attached to the Pi, you can follow the booting process, otherwise wait a minute or two, then fire up a browser on any computer on your network, and head to http://musicbox.local. If that doesn't take you anywhere, point your browser to the IP address of the Pi.

2 CONFIGURE MUSICBOX

The default interface of Pi MusicBox is rather bland because you haven't configured any music source yet. To fix that, click on the "Settings" link in the navigation bar on the left. This takes you to a page from where you can individually enable and configure all the supported streaming services, as well as tweak other settings.

» Expand the "Network" setting to customize the distro's network-related parameters. For example, you can change the name of the workgroup the distro is listed

THE DNA OF PI MUSICBOX

The Pi MusicBox distro is based on the Mopidy music server, which is based on a customized version of the MPD server. MPD stands for Music Player Daemon. It's a music player that uses a client-server model. Separating the music player into two components has a couple of advantages—it means that MPD uses few system resources, and it introduces interesting possibilities, such as remote playback and control, and the ability to use different interfaces.

MPD can also handle audio files in a variety of formats, including Ogg Vorbis, Flac, MP3, and other formats supported by the FFmpeg library. It can also play Ogg and MP3 HTTP streams, can read and cache metadata, has native zeroconf support, and a built-in HTTP streaming server. This is why MPD is ideal for running on low-powered headless servers, while the client can run on any machine in the network. The Mopidy server's implementation of the MPD server inherits many features of the original MPD server, so you can control it remotely from any MPD client.

under on the Windows machines in the network. Also, if you want to move the Pi from being connected via an Ethernet cable to a Wi-Fi network, this section enables you to add the SSID and its password without tweaking the configuration file. Furthermore, you can also enable the option to connect to the distro via SSH. Unlike regular Raspberry Pi distros, you don't really need SSH access to the insides of Pi MusicBox. However, if you do decide to enable SSH access, make sure that you change the default root password by specifying a new one in the next section.

3 TWEAK SETTINGS

Next up is the MusicBox section, which houses some interesting settings. In the "Device Name" field, you can customize the network identity of the distro. This enables you to have several MusicBox instances running on the same network, such as kitchen.local, bedroom.local, garage.local, and so on. If there's an online music station you'd like the distro to play automatically upon boot, you can enter its link in the "Autoplay URL" field. The section also has two toggles that enable you to stream music from other devices to MusicBox (refer to the walkthrough on the right).

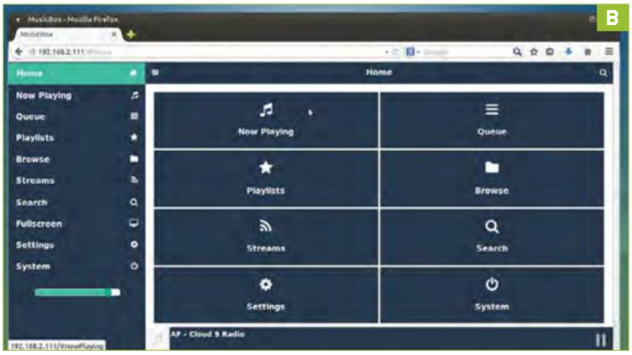
» Audiophiles should pay attention to the settings in the "Audio" section. The "Audio Output" option offers a pull-down menu to help you select the device from which the Pi should output audio. The default "Automatic" setting pipes audio to USB if USB audio is detected. If not, the audio is sent to HDMI, and then finally to the analog output [**Image B**]. The pull-down menu also lists several DACs (digital audio converters), including ones from HiFiBerry and IQ Audio. If you are using a compatible DAC, disable the "Downsample USB" setting, otherwise audio is turned down to 44K.

4 SCAN FOR MUSIC

By default, Pi MusicBox scans for new music files on the SD card it's installed on, and on any attached USB disks. You can also ask it to scan for files under shared Samba folders on the network, by entering their location (such as "//192.168.2.10/Shared/Music") under the "Network Drive" setting in the "Music Files" section. However, scanning for music could take a while, depending on the number of configured locations, and the size of the USB disks. The distro also has the option to disable such scanning under this section. Finally, there's the "Resize Filesystem" option, which is in beta and might corrupt your installation. But if it works as intended, it resizes Pi MusicBox to take over the entire SD card, so you can use the extra space for music.

5 CONFIGURE SERVICES

There are several ways to add music that you own to the Pi MusicBox distro, which you can then play via the "Browse → Local Media" option in the web frontend. You can fetch music from a shared Samba folder on the network by pointing to its location, as mentioned earlier. You can also attach one or several USB disks to the Raspberry Pi, and the distro adds music stored on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MusicBox - Mozilla Firefox
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Home
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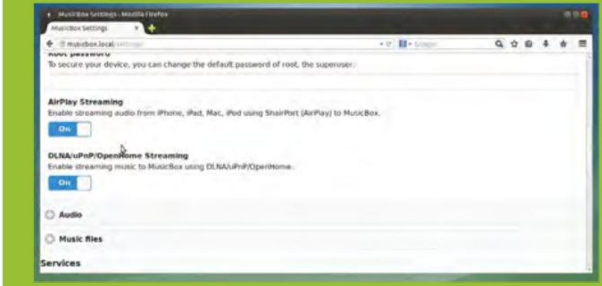
STREAM FROM YOUR MOBILE DEVICES


MusicBox Settings - Mozilla Firefox
MusicBox Settings
musicbox.local
Audio
Music files
Services

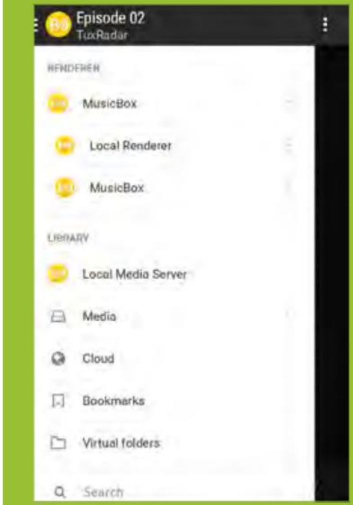
To secure your device, you can change the default password of root, the superuser.

AirPlay Streaming
Enable streaming audio from iPhone, iPad, Mac, iPod using ShairPort (AirPlay) to MusicBox.
On

DLNA/uPnP/OpenHome Streaming
Enable streaming music to MusicBox using DLNA/uPnP/OpenHome.
On

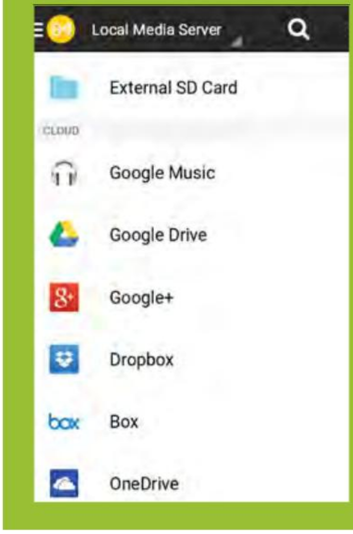
1. ENABLE STREAMING

Pi MusicBox also supports playback via the DLNA protocol. It's disabled by default, but once enabled, you can send music from devices such as your cell phone to the Pi, which plays it from the attached speakers. To enable it, bring up the Pi MusicBox web interface, head to "Settings → MusicBox," and enable the "DLNA Streaming" option.


Episode 02
TuxRadar
RENDERER
MusicBox
Local Renderer
MusicBox
LIBRARY
Local Media Server
Media
Cloud
Bookmarks
Virtual folders
Search

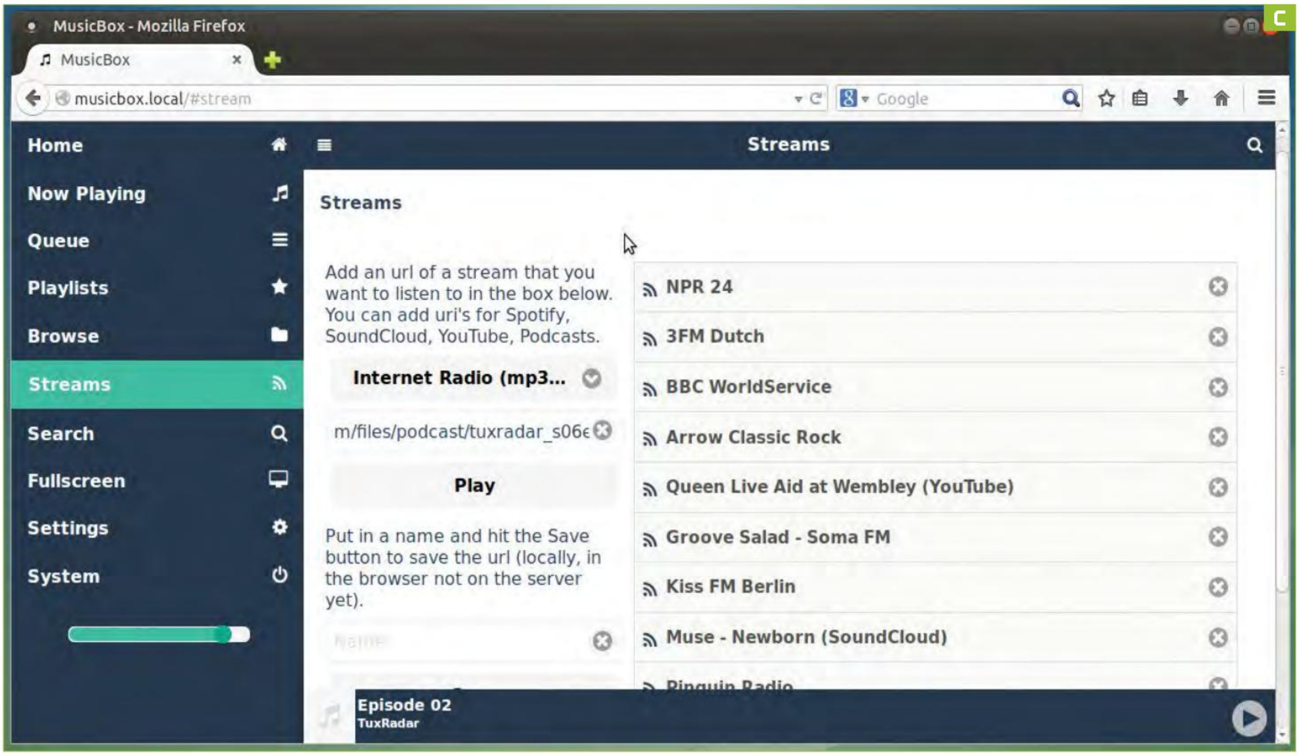
2. INSTALL BUBBLEUPNP

This app is available from the Google Play Store as an ad-supported free download. Install the app and tap on the menu icon on the right. Your Pi MusicBox server should be listed under the "Renderer" section. Tap on it to set it up as the default renderer. Now any music you select to play on this mobile device is sent to the Pi for playback.


Local Media Server
External SD Card
CLOUD
Google Music
Google Drive
Google+
Dropbox
Box
OneDrive

3. STREAM MUSIC

You can now play any music stored on your cell phone, and it streams through the speakers connected to the Raspberry Pi. BubbleUPnP can also stream music stored on online services, including Google Music, Dropbox, OneDrive, and so on. Head to the "Libraries" section and tap on the service to equip it with your account settings.



Streams

Add an url of a stream that you want to listen to in the box below. You can add uri's for Spotify, SoundCloud, YouTube, Podcasts.

Internet Radio (mp3...

m/files/podcast/tuxradar_s06e

Put in a name and hit the Save button to save the url (locally, in the browser not on the server yet).

- NPR 24
- 3FM Dutch
- BBC WorldService
- Arrow Classic Rock
- Queen Live Aid at Wembley (YouTube)
- Groove Salad - Soma FM
- Kiss FM Berlin
- Muse - Newborn (SoundCloud)
- Pinguin Radio

Episode 02
TuxRadar

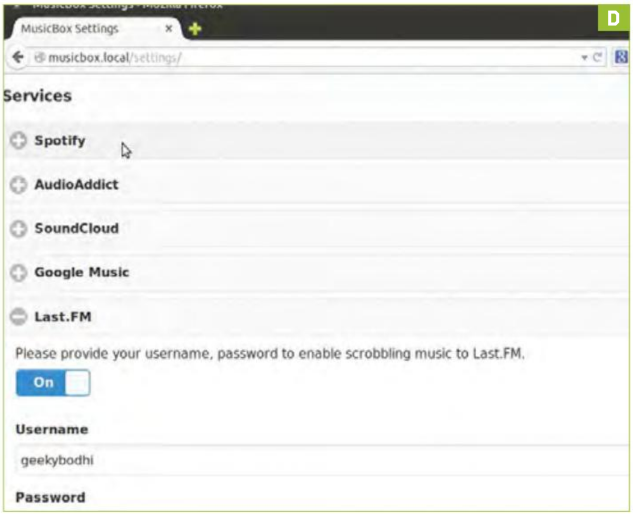
them automatically. If you've expanded the SD card using the beta resizing option mentioned in the previous section, you can copy music directly on to the SD card as well.

›› To load music to the SD card, you can either connect it to your computer or access it via the network while it's attached to the Pi. The distro has a working Samba configuration and should show up in the "Network" section inside the file manager of all OSes. The distro's Samba share has a folder called "Music." You can put any audio file inside this and it is transferred to the SD card.

6 SPOTIFY

In addition to local music, there's quite a handful of services from which Pi MusicBox can get audio files [Image C]. Each of them can be configured separately from under the "Services" section. First up is the popular Spotify service. All you need to do is equip the distro with the authentication information for your Spotify Premium account, and it takes care of the rest. The distro fetches all your playlists, which you can then access from the "Playlists" section in the main interface. If you are on a slower network, or if your data usage is capped, use the "Music Quality" pull-down menu in the Spotify settings section and select the "Lowest" option, which consumes the least amount of bandwidth.

ANOTHER PI TUTORIAL NEXT MONTH



Services

Please provide your username, password to enable scrobbling music to Last.FM.

On

Username
geekybodhi

Password

7 SOUNDCLOUD

Pi MusicBox also has beta support for the SoundCloud service. Before you can enable the service, however, you need to fetch an authentication token by visiting www.mopidy.com/authenticate and logging in to your SoundCloud account. This spits out a long string of numbers that you then need to paste into the "Token" field under the SoundCloud settings.

8 GOOGLE PLAY MUSIC ALL ACCESS AND LAST.FM

Similarly, you can enable Google Play Music All Access by adding the login credentials for your account under the Google Music settings section. If the music from Google Play doesn't show up in the main interface, you need to add an alphanumeric Android Device ID to the configuration as well. You can fetch this by dialling *#*#8255#*#* on your Android phone, or by installing the Device ID app (http://bit.ly/LXFowncloud) from the Google Play store.

›› The distro also supports scrobbling via the Last.fm service, and this is a wonderful way to discover new music [Image D]. To enable it, just enter your login credentials in the Last.fm section. The distro can also play podcasts from iTunes and Gpodder.net, as well as online radio streams from Dirble, Soma FM, and AudioAddict. To listen to them, all you need to do is enable them individually in the "Settings" page.

9 PLAYING AUDIO

Once you have configured all the sources of music, you can head back to the main interface to listen to them. Switch to the "Browse" tab, which lists all the configured sources of music. Select any one, and drill down through the genres or categories until you find the track you wish to play. When you click on it, the track or the radio station starts playing through the attached speakers. Switch to the "Now Playing" tab to control playback.

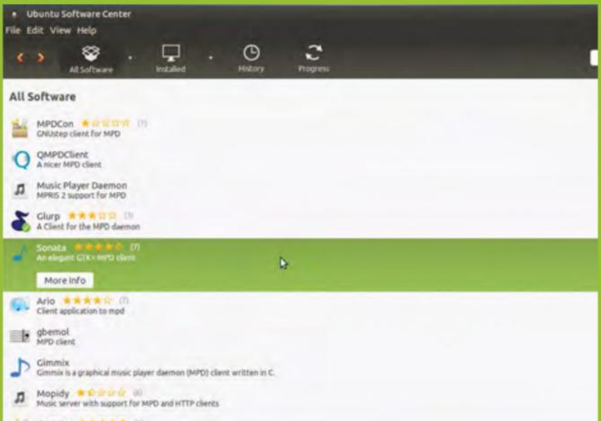
» The "Playlists" tab lists all your playlists from the Spotify service. To find specific music, switch to the "Search" tab and enter a string of text. By default, the distro looks for music matching the text in all the configured services. However, for faster results, you can instead ask Pi MusicBox to search inside a particular service only.

10 ENJOY YOUR MUSIC!

If there's a particular online stream you wish to play back, switch to the "Stream" tab, and paste its URL into the "Internet Radio" box. When adding URLs, remember that you can't use links that point to container files, such as M3U, XSPF, or PLS. You instead have to use links that point to a read stream, such as http://dl.maximumpc.com/maxpc_238_20150420.mp3 which is the URL for an episode of the Maximum PC podcast.

» There are many more ways of interacting with the Pi MusicBox server besides the web-based interface. You can play music via any software that supports the Music Player Daemon (MPD), such as the MPDroid app for Android. ⏻

CONNECT WITH CLIENTS



All Software

MPDCon ★☆☆☆☆ (1)
GNUstep client for MPD

QMPDClient
A nicer MPD client

Music Player Daemon
MPRIS 2 support for MPD

Glurp ★★★☆☆ (3)
A Client for the MPD daemon

Sonata ★★★★☆ (7)
An elegant GTK+ MPD client

More Info

Ario ★★★★☆ (7)
Client application to mpd

gbemol
MPD client

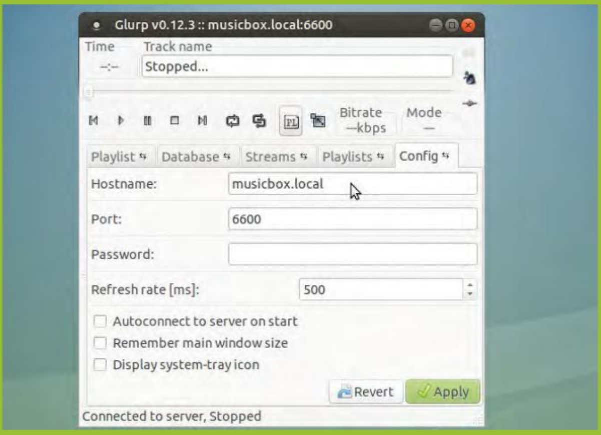
Gimmix
Gimmix is a graphical music player daemon (MPD) client written in C.

Mopidy ★☆☆☆☆ (4)
Music server with support for MPD and HTTP clients

Cantata ★★★★★ (1)

1. GET A DESKTOP CLIENT

Linux distros have several clients in their repos, including Ario, Glurp, Sonata, QMPDClient, Cantata, and more. All apps are equally intuitive, so use the one that integrates with your desktop environment. Some clients, such as Cantata, are cross-platform, and available for Mac OS X and Windows, which also has native clients, such as Chimney.



Time: -:--
Track name: Stopped...

Bitrate: --kbps
Mode: --

Hostname: musicbox.local

Port: 6600

Password:

Refresh rate [ms]: 500

☐ Autoconnect to server on start

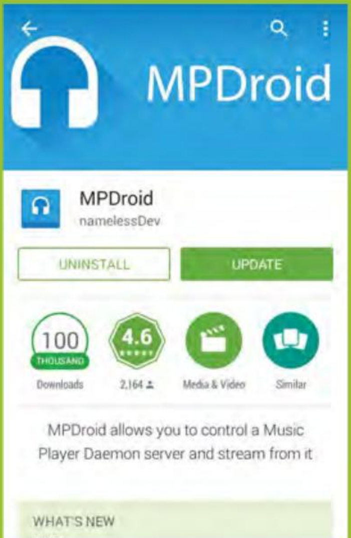
☐ Remember main window size

☐ Display system-tray icon

Connected to server, Stopped

2. CONTROL FROM DESKTOP

All apps need to be hooked to your Pi MusicBox installation. Some ask you for details about your MPD server when you launch them for the first time, while others detect Pi MusicBox automatically, thanks to zeroconf. When asked, enter "musicbox.local" as the hostname of the server, and leave the other settings untouched.



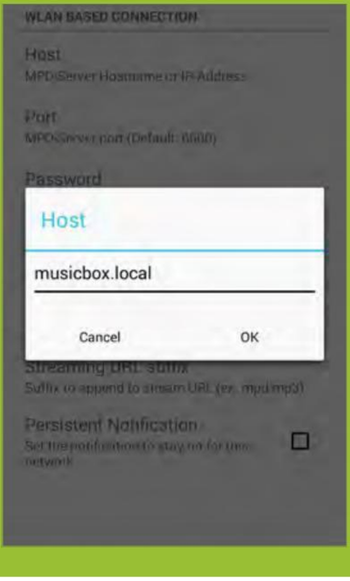
MPDroid
namelessDev

MPDroid allows you to control a Music Player Daemon server and stream from it

1.07

3. GET AN ANDROID CLIENT

To control the Mopidy server from an Android device, you need an MPD client for it. The Google Play store lists a bunch of MPD clients, including the popular MPDroid client. The app is available for free and has user interfaces for both phones and tablets. Using MPDroid, you can search your music collection, and sort it according to categories such as Artists, Albums, Genres, and so on.



WLAN BASED CONNECTION

Host
MPD Server Hostname or IP Address

Port
MPD Server port (Default: 6600)

Password

Host

musicbox.local

Streaming URL suffix
Suffix to append to stream URL (ex. mpd.mp3)

Persistent Notification ☐
Set the notification to stay on for this network

4. CONTROL FROM MOBILE DEVICES

When you launch the app for the first time, you're asked to set it up. You have to first select a preferred WLAN connection, and select your wireless network. In the following screen, tap on the "Host" parameter and then enter the IP address of the Pi MusicBox server. Now head back to the main screen, from where you can browse through and control your music collection.

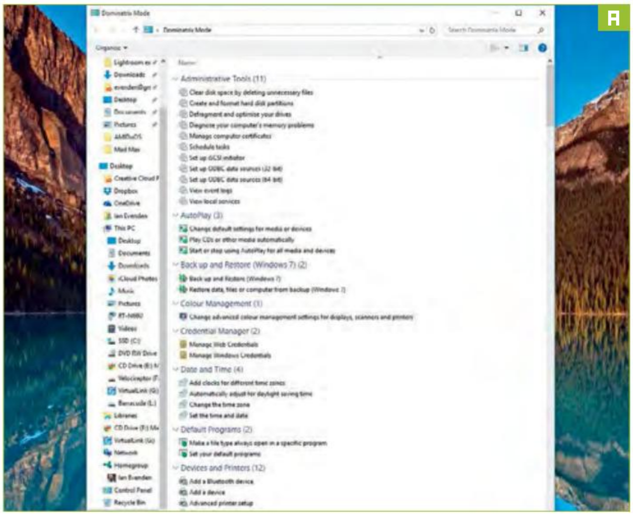
Become a Windows God

YOU'LL NEED THIS

WINDOWS 10
Though you'll find this equally useful if you're still using Windows 8.

ANYONE WHO'S BEEN USING WINDOWS 10 for a while will know the pain of trying to find a particular setting. Anything more involved than changing the screen wallpaper, or turning Wi-Fi on and off again, can be done in any of three places. And the Control Panel, despite its new stripped-back white minimalist loveliness, isn't always completely helpful when it comes to pointing you toward the settings you need. Wouldn't it be great, then, if you could gather all the settings together, like cattle in a Texas corral? A single place where you could look for troublesome system settings or motherboard properties. Well, you can.

Once you've created the God Mode folder, you'll find more than 200 entries for settings and preferences from across your PC. While Windows 10 streamlined the locations of its various settings, anyone still using Windows 8 will find this especially useful, because they still live under the tyranny of the Charms bar. –IAN EVENDEN



Administrative Tools (11)
- Clear disk space by deleting unnecessary files
- Create and format hard disk partitions
- Defragment and optimise your drives
- Diagnose your computer's memory problems
- Manage computer certificates
- Schedule tasks
- Set up iSCSI initiator
- Set up ODBC data sources (32-bit)
- Set up ODBC data sources (64-bit)
- View event logs
- View local services

AutoPlay (3)
- Change default settings for media or devices
- Play CDs or other media automatically
- Start or stop using AutoPlay for all media and devices

Back up and Restore (Windows 7) (2)
- Back up and Restore (Windows 7)
- Restore data, files or computer from backup (Windows 7)

Colour Management (1)
- Change advanced colour management settings for displays, scanners and printers

Credential Manager (2)
- Manage Web Credentials
- Manage Windows Credentials

Date and Time (4)
- Add clocks for different time zones
- Automatically adjust for daylight saving time
- Change the time zone
- Set the time and date

Default Programs (2)
- Make a file type always open in a specific program
- Set your default programs

Devices and Printers (12)
- Add a Bluetooth device
- Add a device
- Advanced printer setup

1 CREATE A GOD MODE FOLDER

Unfortunately, the code is a bit more complex than "IDDQD." Create a new folder (right-click and choose "New → Folder"), and name it "GodMode.{ED7BA470-8E54-465E-825C-99712043E01C}." Find it online and copy and paste—it's easier—although the first word (or words, with spaces) before the period, which becomes the name of the folder, can be whatever you want [**Image A**]. "Dominion," maybe. Or "Divine Right Of Kings." "Exploit The Tweak." Whatever you choose, a folder with that name appears on your desktop. We've chosen "Dominatrix Mode" because we're children who still feel funny when we think about *WOW*'s Succubus.

2 OPEN THE FOLDER

The folder's icon should change to that of the Control Panel. Double-click to open it, and you'll find something not dissimilar to the Control Panel—except there are many more options. Over 200, in fact.

3 WHAT'S INSIDE?

There's nothing here that you won't find elsewhere, scattered across Windows' myriad settings and preference panes. The beauty of God Mode is that it gathers them in one place, so you don't have to go searching for the setting you need, or play the fun Control Panel Guessing Game about which category what you need will be found in. The folder is simply organized from A to Z, with a search box at the top.

4 ADMIN TOOLS

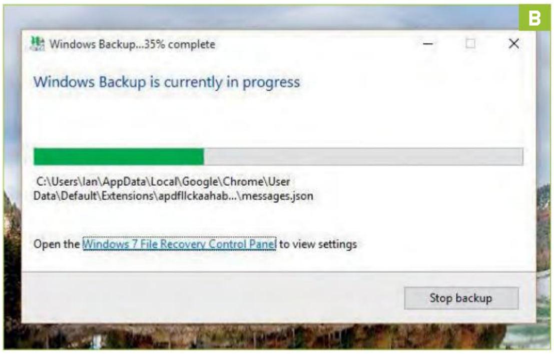
First up are the Admin tools, including defragging for improving the performance of cluttered non-SSD drives, the creation and formatting of drive partitions, and the Task Scheduler, for making your friend's PC play Slipknot at 3 a.m.

5 AUTOPLAY

Slightly more interesting is the next section, "Autoplay," which enables you to change settings that usually only appear when you plug a new removable drive into the PC. Double-click the first option, "Change default settings," and you can alter how your PC reacts to all kinds of removable media, including turning Autoplay off altogether if it's getting too much.

6 BACKUP

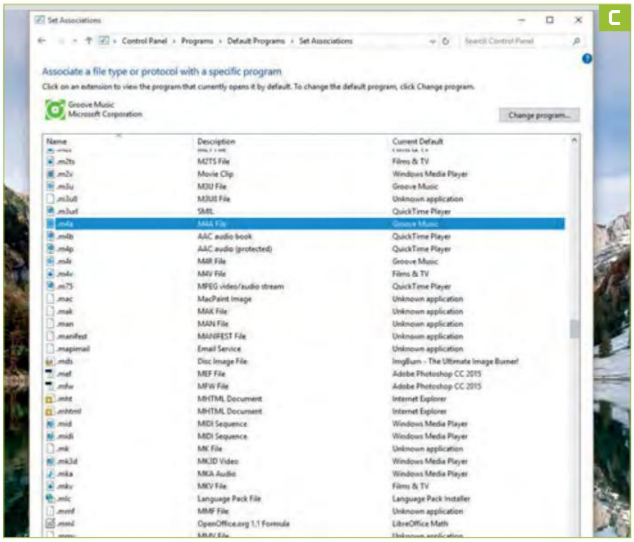
"B" is for "Backup," and that's the next item on the list. It may say Windows 7 after it, but this backup utility works in Windows 10, after its sad removal from Windows 8.1. Click it, pick a target drive with lots of free space, allow Windows to manage your backups, and... off it goes [**Image B**]. You can choose to manually select what is



Windows Backup is currently in progress

C:\Users\Ian\AppData\Local\Google\Chrome\User Data\Default\Extensions\apdfllckaahab...\messages.json

Open the Windows 7 File Recovery Control Panel to view settings



Set Associations

Control Panel › Programs › Default Programs › Set Associations

Search Control Panel

Associate a file type or protocol with a specific program

Click on an extension to view the program that currently opens it by default. To change the default program, click Change program.

Groove Music
Microsoft Corporation

Change program...

Name	Description	Current Default
.m2ts	M2TS File	Films & TV
.m2v	Movie Clip	Windows Media Player
.m3u	M3U File	Groove Music
.m3u8	M3U8 File	Unknown application
.m3url	SMIL	QuickTime Player
.m4a	M4A File	Groove Music
.m4b	AAC audio book	QuickTime Player
.m4p	AAC audio (protected)	QuickTime Player
.m4r	M4R File	Groove Music
.m4v	M4V File	Films & TV
.m75	MPEG video/audio stream	QuickTime Player
.mac	MacPaint Image	Unknown application
.mak	MAK File	Unknown application
.man	MAN File	Unknown application
.manifest	MANIFEST File	Unknown application
.mapimail	Email Service	Unknown application
.mds	Disc Image File	ImgBurn - The Ultimate Image Burner!
.mef	MEF File	Adobe Photoshop CC 2015
.mfw	MFW File	Adobe Photoshop CC 2015
.mht	MHTML Document	Internet Explorer
.mhtml	MHTML Document	Internet Explorer
.mid	MIDI Sequence	Windows Media Player
.midi	MIDI Sequence	Windows Media Player
.mk	MK File	Unknown application
.mk3d	MK3D Video	Windows Media Player
.mka	MKA Audio	Windows Media Player
.mkv	MKV File	Films & TV
.mlc	Language Pack File	Language Pack Installer
.mmf	MMF File	Unknown application
.mml	OpenOffice.org 1.1 Formula	LibreOffice Math

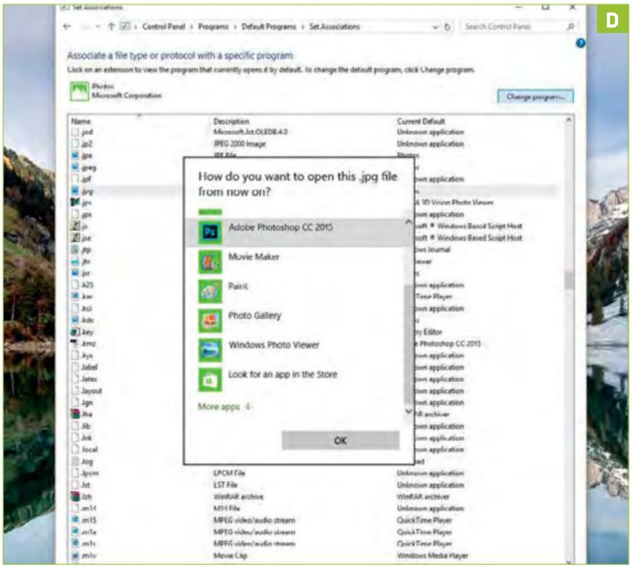
and isn't backed up if you like, but Windows does a pretty good job, and knows where all the important stuff is.

7 FILE DEFAULTS

Default programs are the ones that launch automatically when you double-click a folder [**Image C**]. For a Word document, you may well want Word, but if you open a JPEG, would you prefer Photoshop rather than Windows Picture Viewer [**Image D**]? This is where you change it. Select the .jpg file extension from the enormous list, click the "Change Program" button at the top, and a list appears of programs Windows thinks may be able to open the file. Choose the program you want to use—if it's not on the list, click "More apps." Still not there? Click "Look for another app on this PC," which lets you browse to the app of your choice.

8 EASE OF ACCESS

Further down the list, past the arcane mysteries of Bluetooth and Printers (whatever they are), you'll find the Ease of Access Center for useful things like turning off animations if they give you motion sickness, or the on-screen keyboard for those times you only take a mouse to the couch to watch Netflix, and can't be bothered to get up again. The Internet Options are a little further on, so you can delete cookies, enable pop-up blocking, or clear those embarrassing Netflix movies from your history. *Breast Men* (1997) is a fine example of celluloid art, but perhaps not something you should admit to watching while around your mother. And you know she looks at your internet history.



Control Panel › Programs › Default Programs › Set Associations

Search Control Panel

Associate a file type or protocol with a specific program

Click on an extension to view the program that currently opens it by default. To change the default program, click Change program.

Photos
Microsoft Corporation

Change program...

Name	Description	Current Default
.jod	Microsoft.Jet.OLEDB.4.0	Unknown application
.jp2	JPEG 2000 Image	Unknown application

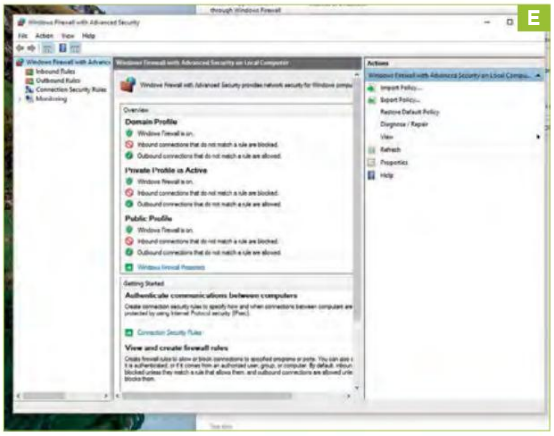
How do you want to open this .jpg file from now on?

- Adobe Photoshop CC 2015
- Movie Maker
- Paint
- Photo Gallery
- Windows Photo Viewer
- Look for an app in the Store

More apps ↓

OK

Name	Description	Current Default
.lpcm	LPCM File	Unknown application
.lst	LST File	Unknown application
.lzh	WinRAR archive	WinRAR archiver
.m14	M14 File	Unknown application
.m15	MPEG video/audio stream	QuickTime Player
.m1a	MPEG video/audio stream	QuickTime Player
.m1s	MPEG video/audio stream	QuickTime Player
.m1v	Movie Clip	Windows Media Player



Windows Firewall with Advanced Security

File Action View Help

Windows Firewall with Advanced Security
Inbound Rules
Outbound Rules
Connection Security Rules
Monitoring

Windows Firewall with Advanced Security on Local Computer

Windows Firewall with Advanced Security provides network security for Windows compu

Overview

Domain Profile
- Windows Firewall is on.
- Inbound connections that do not match a rule are blocked.
- Outbound connections that do not match a rule are allowed.

Private Profile is Active
- Windows Firewall is on.
- Inbound connections that do not match a rule are blocked.
- Outbound connections that do not match a rule are allowed.

Public Profile
- Windows Firewall is on.
- Inbound connections that do not match a rule are blocked.
- Outbound connections that do not match a rule are allowed.

Windows Firewall Properties

Getting Started

Authenticate communications between computers

Connection Security Rules

View and create firewall rules

9 MORE OPTIONS

Anyway, further down the list, past "Mouse Options" and something called a "modem," we find our old friend "Add and Remove Programs"—something the *Maximum PC* team is always having to use the Control Panel search to find. Remote access is just below it, and below that is "Security and Maintenance," where you'll find actually-important stuff, like user account controls and error reports. Further on, there's text-to-speech and speech recognition settings, too, for those who like to think we're on the bridge of the *Enterprise*.

10 SYSTEM SETTINGS

Finally—well, almost finally—there's "System." From here you can check your processor speed, tweak performance, fiddle with virtual memory, and access the Task Manager to kill errant processes that won't close by any other means. Windows Defender and Windows Firewall live right at the bottom of the list [**Image E**], two things that are generally just switched on and left alone. You might need to access the firewall if you're messing with an app that needs internet access but isn't on Microsoft's list, however. ⏻

MICROSOFT'S CUSTOMER IMPROVEMENT PROGRAM

If privacy is important to you, you might want to opt out of Microsoft's Customer Improvement Program—it's under "Security and Maintenance" in the God Mode folder. This background process collects anonymous information about your PC as you work, and sends it to Microsoft. It does this with a scheduled task, which should run at a time you're not using your PC. Under Windows 7, however, it was noted that disabling it improved performance—so there's no reason to leave it running if you want to squeeze every drop of juice out of your current build. Or, if you're feeling philanthropic, you could leave it on and help Microsoft improve the features of Windows, based on your usage.

Extreme Audio Editing with RX 5

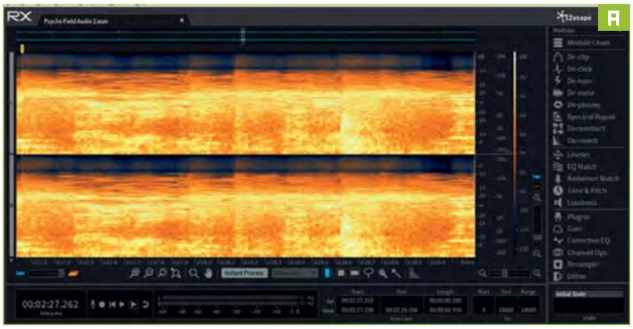
YOU'LL NEED THIS

IZOTOPE RX 5
Buy it ($349) or Try it from www.izotope.com.

HEADPHONES OR SPEAKERS
You need some way of hearing what you've done!

FED UP OF AUDIO CHILD'S PLAY? With plenty of freeware tools out there, basic audio editing is a cinch, but what do you do when you need to go further? Want to isolate and remove unwanted sound? It's possible. Perform futuristic noise removal? There are ways. Rescue a badly damaged recording? Stranger things have happened.

You don't need the best computer in the world to make these things happen, but you do need some sophisticated software—the kind previously dreamt of by intelligence services and shady government agencies. Izotope's RX package is like Photoshop for audio, and version five has just been released. The tutorial on these pages gives you an intro to the techniques this powerhouse software uses to clean up a less-than-stellar audio recording, but it's not the only option—there are alternative pieces of software that'll do similar jobs, detailed opposite. –JAMES RUSSELL



1 GET STARTED

Load an audio file into RX 5 using the software's menus or by dragging one in. The file is displayed in the classic waveform view—a single waveform for a mono file; two for a stereo one—but that's not what we're after. There's a slider below the bottom-left of the display. Sliding it to the right blends in RX's Spectrogram view.

2 SPECTROGRAM VIEW

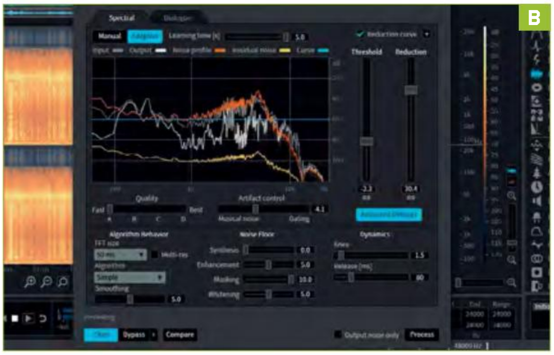
The Spectrogram view plots frequency (low to high sounds) from bottom to top along the y axis, and time across the x axis. The brightness of the plot at any point represents the amplitude (level) at that point in the signal [**Image A**]. Unlike a traditional waveform editor, we can reach in and select different regions of the sound at any point, using lasso, magic wand, or box selection tools—it really is like audio Photoshop!

3 BACKGROUND NOISE...

Let's start by taking out some of the background noise. Most noise removal systems need you to play them a sample of the noise signal in isolation, to be able to detect and subtract it from the entire signal. RX can do this—and its selection tools make it easier to reach in and identify areas of pure noise—but we'll see how it handles automatic removal. In this case, the same processes are happening under the hood, only the software is identifying "what noise is" itself.

4 ...REMOVED

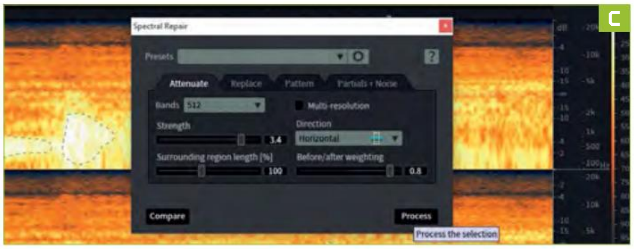
Double-click on the spectrogram to select the entire signal. Head to the "De-noise" tool [**Image B**] on the right-hand panel. In Adaptive mode, the De-noise module analyzes and determines what is noise automatically. Hit "Preview" to hear how good a job it's doing, then tweak the "Threshold" (how loud the noise is) and "Reduction" (how much noise should be taken away) sliders to optimize the process. Notch the "Quality" up higher if your system can handle it for online processing. When you're happy with the results, hit "Process."



FORENSIC AUDIO & SPECTRAL REPAIR

Today's audio technology provides opportunities that would have been completely impossible in the past. Nowadays it's entirely possible—if you know what you're doing—to manipulate and restore bad quality audio to a passable standard. Skills like these are important within the justice system, with forensic audio professionals analyzing and restoring "incidental" field audio to a comprehensible state that can be used in court.

The most useful skills and technologies to this end are noise and ambience removal, which restore the intelligibility of the speech signals, focusing consonants in speech patterns and making them less ambiguous. All the while, extra special care must be taken to preserve accuracy, arriving at the right signal, not the one that sounds right.



Bands 512

☐ Multi-resolution

Strength 3.4

Direction Horizontal

Surrounding region length [%] 100

Before/after weighting 0.8

5 DELETE UNWANTED SOUNDS

At one point, there's an unwanted bang. Because we're using a spectrogram view, we can zoom in, select it, and hit "Delete" to reduce the volume of that region only—goodbye squeaky chairs, coughs, and airhorns! But we can be cleverer than this....

6 SPECTRAL REPAIR

Zooming in and selecting the offending sound (and adjusting the color-temperature scale on the right to help locate it if necessary), we can select the Spectral Repair module [**Image C**]. Its mission is to remove a sudden intrusive sound while interpolating what should be left behind it—rather than just deleting it. The "Attenuate" tab compares your selection to what's outside it, or the "Replace" tab can fill the blanks in gappy audio. For better results, approach each region of unwanted sound individually, rather than using Shift-select for multiple regions.

7 DE-CLICKING

Any recording equipment is susceptible to interference, whether of the human or the electrical kind. These clicks and pops—however they were created—can be taken out of the equation with RX's algorithms. This is a global process, so select the entire audio region you need processed, and let the De-click module get rid of unwanted clicks, crackles, and thumps.

8 DE-CLIPPING

If a microphone receives too loud a sound, the recording software can't write data above a certain loudness, and the recording clips. A 16-bit recording tops out at 96 decibels above whatever volume it considers "zero" to be, for example. When zoomed into the traditional waveform view, the waveform travels up or down to its maximum extent, gets cut off, and all data past the extremes is lost. Modern software can make a reasonable guess at getting it back, again interpolating the missing pieces from the content of the unselected areas.

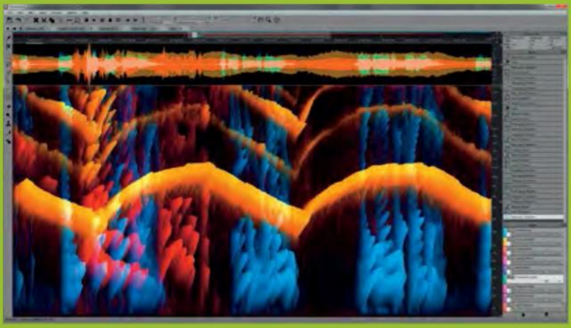
9 DE-REVERB

Any recorded audio is subject to reflections of the original sound off the surfaces of that environment—reverb. If your audio was recorded in a large environment or a bare, unfurnished room, speech can become less intelligible due to those loud, delayed reflections. Using the De-reverb module's "Learn" function works best if you select and feed it an "impulse" of audio—an isolated clap, gunshot, or other "bang." This helps it detect the makeup of the room the recording was made in. Tweak the "Reduction" slider to emphasize or de-emphasize the room sound.

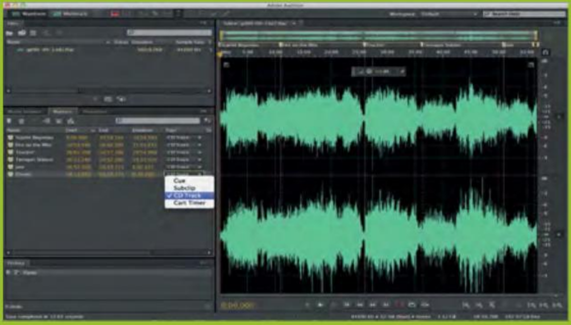
10 LEVELING DIALOG

Perhaps the key part of making any dialog sound better—once you have a good recording—is leveling. Commercial broadcasts keep speech at more "compressed" state, reducing the loud parts and pulling up the quieter parts, and RX's Leveler module does just this. Set a target level and dial in any "Ess Reduction" (removing sibilant "S" sounds) and "Breath Control" for a louder, more polished audio experience. ⏻

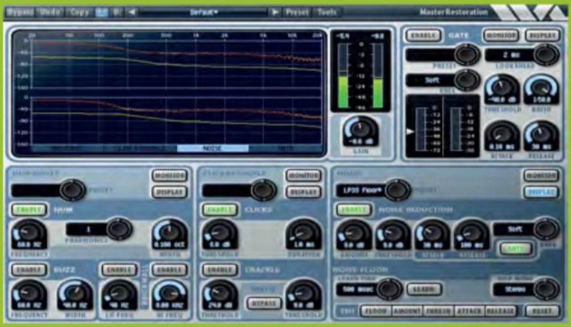
ALTERNATIVE APPS



SONY SPECTRALAYERS PRO 3 *($400)*
SpectraLayers' spectrogram is well presented and customizable, representing complex audio data in many different ways. It's got the usual "forensic" and restoration features, plus separation, pitch correction, and the ability to "imprint" the characteristics of one piece of audio on to another. Total voodoo.
www.sonycreativesoftware.com



ADOBE AUDITION CC *($19.99 per month)*
Audition has plenty of modules for sorting out specific audio problems, and can work well with batch processing, as well as integrating with the rest of the CC suite. It's a better choice for commercial audio production rather than hugely in-depth technical engineering tasks.
www.adobe.com



WAVE ARTS MASTER RESTORATION *($349)*
Four plugins (VST/DX/RTAS) to boost your current software: a noise remover, click remover, hum remover, and a gate, plus a fifth plugin that runs all four together. Great results.
www.wavearts.com

BUILD IT

ALEX CAMPBELL **ASSOCIATE EDITOR**

Team Red Comes Back in Black

We took some high-end AMD parts and put them into this darkly beautiful rig

LENGTH OF TIME: **1–3 HOURS** LEVEL OF DIFFICULTY: **EASY**

CHECK ONE, TWO

SOMETIMES IT CAN BE incredibly tempting to go with what's familiar. For us, Intel tends to be our preference when we look for a performance CPU. But we asked ourselves: What if we went full-on Team Red?

Sure, AMD doesn't make a part that can compare to the Core i7-5960X, but that doesn't mean it doesn't offer some good CPUs. And on the upside, you generally pay less for an AMD CPU, which means that gamers or builders on a budget can still have a good experience without as much of a hit to the wallet. After all, the 5960X is $1,000.

We also wanted to find an excuse to build into the NZXT Noctis 450 that had been sitting in our office for a few months. Once we opened the box, we wondered why we hadn't built into it earlier. The Team Red theme went together with the black and red accents of the case perfectly.

We feel like this build is a great example of what you can do with the darker, redder side of the PC parts market. Combined with the red accents on our GPU and RAM, this build really shines as one of our favorites in terms of aesthetics.

THE SET LIST

WHEN WE STARTED piecing together this rig, we went hunting around our lab for AMD parts we had to hand. We happened upon the foundations of what would make our build: an eight-core AMD FX 9370 and an ASRock Fatal1ty 990FX Killer mobo.

The FX 9370 makes use of AMD's Vishera core, which is a little on the thirsty side. With a TDP of 220W, we had to make sure we cooled it if we wanted to keep it stable, so we grabbed a Cooler Master Nepton 280L, with its big 280mm radiator.

As for video, we couldn't resist using our Asus R9 Fury Strix. Although it's not AMD's biggest, baddest GPU (the 9370 isn't the top of AMD's offerings either), the Fury holds its own. Think of the Fury and the Fury X in the same terms you would the 980Ti and Titan X.

As for the rest, we nabbed 8GB of Corsair Vengeance RAM to fill two of the four DIMM slots on our 990FX mobo. And keeping with our theme, the RAM had to be red. For storage, we went with a 250GB M.2 Samsung 850 EVO and a 3TB Seagate Barracuda spinning drive.

The power supply was tricky. As we were in the midst of moving office, we had a hard time finding a PSU that would be a good match. We eventually found a Corsair RM650, which worked well. However, if you want to overclock this GPU or CPU, go find a PSU rated at least 750W. The 650W unit got our benchmarks done without a problem, but we'd really like the extra headroom for overclocking.

INGREDIENTS

PART		STREET PRICE
Case	NZXT Noctis 450	$140
Motherboard	ASRock Fatal1ty 990FX Killer	$120
CPU	AMD FX-9370 Vishera	$210
Memory	8GB Corsair Vengeance DDR3 1600 (red)	$47
GPU	Asus Radeon R9 Fury Strix	$570
PSU	Corsair RM650 (80 Plus Gold)	$107
HDD	3TB Seagate Barracuda	$90
SSD	250GB Samsung 850 EVO M.2	$108
CPU Cooler	Cooler Master Nepton 280L	$120
Total		$1,512

1

FLYING HIGH AGAIN

THE NEPTON 280L kept us cool during tests, but before we could run them, we had to mount the big radiator somewhere. The Noctis 450 is a midtower, so there's not much room inside. But there's plenty of room up top.

With a little effort making sure to release all the round catches at the top of the inside of the case, you can release the whole top plastic molding in one piece. We found that if you put it in just the right spot, you can place the big 280mm radiator on top of the fan mounts and still get the top to attach properly. This is a big space saver, and also helps support the big radiator.

Luckily, this case isn't built with 5.25-inch optical drive bays in mind, so we could snake the tubing for our cooler in the "drive bay" where the ODDs would normally go.

2

ROCK YOU LIKE A HURRICANE

MOST BUILDERS know that AMD parts can get toasty under load, so good cooling is essential. As we had our CPU covered with a 280mm radiator, we needed to make sure our R9 Fury got all the airflow it could handle.

The Noctis 4509 comes with four case fans: one up front, two up top, and one in the rear. Since we wanted to place our CPU cooler up top, we moved those two fans to the front to help keep the Fury fed with fresh air.

We also mounted our radiator with a pushing exhaust configuration, so making sure we had enough cool air for the radiator was a must.

When we snapped the front panel back on, there were no lights from the fans or front of the case, which made for a sleek black matte look that really impressed. You don't need LEDs on all your parts. Even if we had LED fans up front, we doubt we'd be able to see them.

3

NO SHELTER

WE'VE BECOME BIG FANS of using an M.2 form factor SSD whenever possible. This Samsung 850 EVO is no exception.

Don't expect NVMe speeds here: This SSD runs pure SATA mode and offers the same speed as a 2.5-inch model. But both the 2.5-inch and the M.2 are about the same price, so why not go M.2? It saves on cabling mess and improves our airflow.

The only downside to installing an M.2 SSD is you have to install it before your video card. The other upside is that when you finally do want to upgrade to NVMe, you've got the platform to do so. On most motherboards, the switch from SATA to NVMe mode can be made with the help of a simple BIOS option.

Of course, another downside to using M.2 is that your storage isn't shielded behind a plastic or aluminum casing. It's exposed to mishaps and damage if you're not careful.

Killer E2200
SLI
ASRock
990FX KILLER
Killer
250GB

4

THE MEMORY REMAINS

WHEN WE INSTALLED our 3TB Barracuda, we realized you can't see the drive easily from the "front" with the panel off. NZXT decided to build a partition in the Noctis 450 that makes the drive inaccessible from the front. Instead, you have to take off the "back" panel to add or remove hard drives. This can be a pain in the butt when your cable management makes it difficult to get the back panel closed in the first place.

As much as that can be an annoyance, there is a bit of logic: By mounting drives this way and keeping that partition, the build looks cleaner with the "front" panel taken off. It also helps channel air from the fans toward the PCIe slots and CPU, as opposed to letting it fly about everywhere.

We just recommend steering away from the idea of using this case if you'll be swapping out hard drives often; opening the back panel is rarely fun.

5

THE PATIENT

WORKING ON A PC can feel like working in an operating room. In this build, one of the more hairy parts was trying to install the GPU. Just as that hard drive partition makes life painful when messing with your hard drives, it also made things interesting when installing our R9 Fury Strix.

At 11.8 inches long, the R9 Fury Strix needs a lot of space in a case. The space was there in the Noctis 450, but it took a bit of wiggling to get the GPU put in place. To do it, we had to back the card into the hard drive cage partition before moving it forward to insert and seat it in its rightful slot. This wasn't difficult, but it did require a bit of patience.

If we wanted to add a card to use in Crossfire, it would be interesting to try to fit it in. On the plus side, the GPU looks handsome, while conforming to our black-and-red theme.

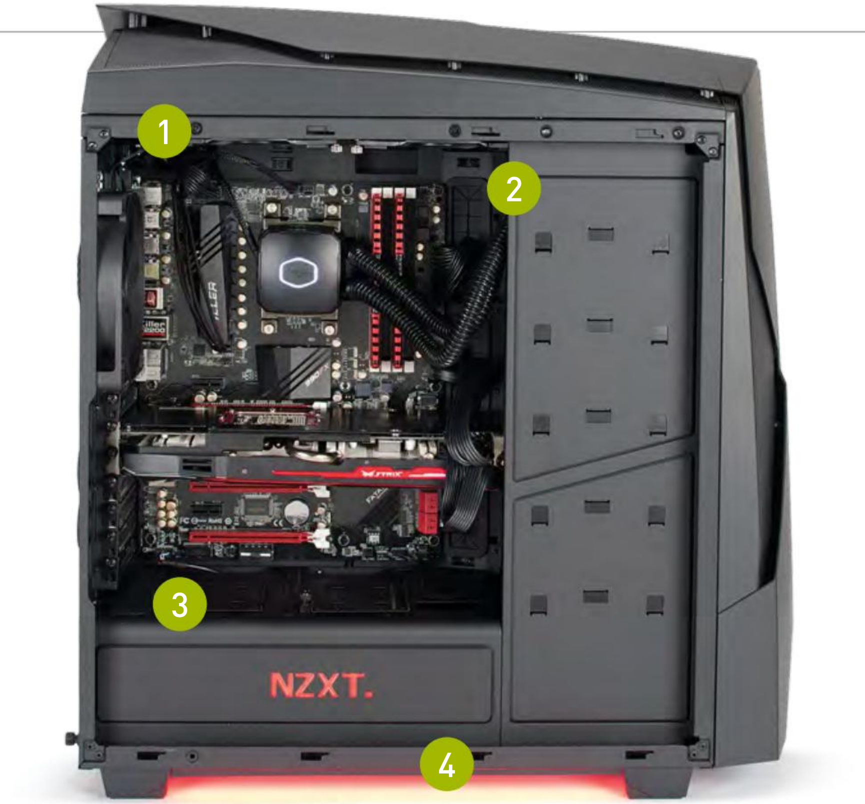
6

UNDER THE SURFACE

ONE OF THE REASONS this build looks so clean is the power supply partition that NZXT built into the Noctis 450.

Such partitions are often underestimated, but they help the build stay organized. If you don't have a modular PSU, spare cables can be coiled and zip-tied away inside the partition. The loose end of SATA and power cables, too, can find a home there. The partition also allows for dedicated airflow for the PSU (and more optimized airflow for the motherboard compartment), and can keep heat contained.

The downside is that installing your PSU is not as straightforward. You can't just plop it in place. Instead, you have to slide the PSU into position, often by removing a bracket, where you see the PSU mounting screw holes. And you have to mount the PSU with the fan facing downward, as there isn't a lot of room for efficient intake from the top.



1 While we probably had enough room to mount the radiator below the bracket, keeping it up top gave us more space and kept things from looking cluttered.

2 The bevel line you see creates a channel for stowing big cables, keeping cable bulge to a minimum.

3 Using the cutouts in the top of the PSU partition makes routing audio and USB connections much cleaner.

4 While it would look gaudy on other cases, the underglow effect is nice because it's the only external LED lighting on the all-black case, save for a red LED behind the power button.

THE SOLO AND BREAKDOWN

WHEN WE WERE ALL FINISHED, this was one of our favorite builds in terms of looks. The interior looks clean, and the red-and-black theme has a darkly evil appeal reminiscent of *Command and Conquer*'s Brotherhood of Nod. But looks aren't everything.

When we ran our graphics benchmarks, we couldn't really expect a single Fury to stand up to the wrath of three GTX 980s. However, this system did offer some promising marks.

The *Shadow of Mordor* benchmark returned a score of 44.2 frames per second on average at 2160p. That's enough to make it into the playable realm at 4K, no easy feat.

Tomb Raider didn't fare as well at 4K, with 38.5fps. That's too close to 30fps for our blood. However, if you really want to play *Tomb Raider* at 4K, turning down (or off) antialiasing could bump up the frame rate. With these marks, playing at 1440p would be just fine.

In *Batman: Arkham City,* we saw what this card could do at 1440p. Again, the marks aren't as high as a 980Ti would be, at 89fps, but they are playable. With a FreeSync monitor, playing at that resolution would be enjoyable.

Remember that these benchmarks are stress tests with all (non-GPU-specific) settings maxed out. Turning down settings can yield dozens of extra frames per second.

When we fired up 3DMark Fire Strike Ultra, we saw our rig get a respectable score of 3,515, comfortably above the Oculus Rift recommended spec score of 2,596.

Our CPU benchmarks returned much lower scores than the i7-5960X in our zero-point. Though the Vishera's octa-core offered more than a quad-core, the 5960X's Hyper-Threading, smaller process (22nm versus 32nm), and higher L3 cache (20MB versus 8MB) produced a faster machine. But the 5960X is a $1,000 CPU. The FX-9370 is $210.

The single-threaded benchmarks returned a much smaller delta than the corresponding difference in price. Considering that the FX-9370 costs 79 percent less than the 5960X, a delta of about 40 percent in Stitch and 23 percent in ProShow isn't all that bad.

Once we got into our multithreaded benchmark, the performance gap widened to canyon-size. The 5960X has more L3 cache and Hyper-Threading, so instead of eight logical CPUs, it has 16. That's twice what the Vishera offered, and the FX-9370 fell behind.

On the bright side, the CPU stayed cool with the help of the Nepton 280L. During the CPU-intensive x264 encoding test, we saw a peak CPU temp of 52 C. Likewise, Fire Strike Ultra only topped out at 48 C. That leaves plenty of thermal headroom for overclocking. Speaking of which, if there is one thing we could have done differently it would be the power supply. Going with a 750- or 800-watt PSU would give you all the headroom you need to overclock safely. We weren't comfortable with the idea with only 650 watts to work with. ⏻

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	806	1,087 (-34.9%)
ProShow Producer 5.0 (sec)	1,472	1,814 (-23.2%)
x264 HD 5.0 (fps)	33.8	13.3 (-60.7%)
Batman: Arkham City 1440p (fps)	204	89 (-56.4%)
Tomb Raider 2160p (fps)	87.5	38.5 (-56%)
Shadow of Mordor 2160p (fps)	70.1	44.2 (-36.9%)
3DMark Fire Strike Ultra	8,016	3,515 (-56.1%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a 5960X CPU, three GTX 980s, and 16GB of RAM. *Arkham City* tested at 2560x1440 max settings with PhysX off. *Tomb Raider* at Ultimate settings. *Shadow of Mordor* at Max settings.

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REVIEWS

TESTED. REVIEWED. VERDICTIZED.

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MAINGEAR SHIFT
PAGE 74

The Maingear Shift is the premium race car of enthusiast rigs.

GEFORCE GTX
GEFORCE GTX
GEFORCE GTX
EXTREME
CORSAIR
AX1200

Maingear Shift

Running on all cylinders

IN MANY WAYS, owning an enthusiast rig is like owning a high-end sports car. They are often both bold and beautiful on the outside, but monstrously powerful on the inside. Maingear is going all in with that mantra with its revamped and turbo-injected Shift systems.

Maingear's full-tower Shift chassis measures a beefy 8.6x24x21.5 inches, but the first thing you'll notice about our unit is its stellar paint job. Maingear sent us a Shift in "Hellcat Green," and we find it reminiscent of the iconic green Mitsubishi Eclipse from the original *The Fast and the Furious* movie. Maingear's paint jobs are done in-house and are car-grade quality. The silkiness rivals that of Smooth Creations, which we've used for our Dream Machines. In case the green doesn't do it for you, the Shift comes in a wide variety of colors that you can choose from.

Underneath the hood, you'll notice that the motherboard isn't set up conventionally; it's rotated 90 degrees, so that the GPU exhaust heat flows toward the ceiling, as opposed to the back, which leverages the fact that heat rises. This also means that its various ports are at the top of the rig, rather than the back. To combat the rat's nest of cables that necessarily come out of the roof of your rig with this setup, Maingear provides a top cover that screws down on to the system once you have everything plugged in. There's plenty of clearance here; after you've got the top cover on, the cables just flow through a large opening at the rear. It certainly keeps the system looking nice and neat, but it is a bit of a hassle if you want to plug in something new, as you have to unscrew the lid. We're tempted to leave the lid off, but it looks much uglier without it. Luckily, there's a pop-up front panel that provides two USB ports, but because the lid can be a nuisance to deal with, we wished Maingear would have included four USB ports here.

It's worth mentioning that if you want to take off the side doors, you also need to have the top off. Luckily, the Shift comes with a windowed side panel, so you can quickly scope out your internals. It's also super sexy inside, with white LED lights strewn about. Overall, a lot of care and attention to detail has gone into the aesthetics of the rig, and it's one of the prettiest full-tower systems we've seen. The cables are clean and green, and match the paint job. The engraved Maingear logo and power/reset buttons below the front swinging door also look amazing.

The design isn't perfect, however. Our system only had room for three-way SLI. In keeping with the race car theme, we also think it would have taken the rig to the next level if it had some awesome green underglow beneath the chassis.

BUILT FOR SPEED

As beautiful as the Shift is, it's also super fast. Our unit came with a 5960X clocked at 4.5GHz, 16GB of DDR4 RAM clocked at 3,000MHz, and three GeForce GTX 980 Tis with core clocks boosted up to 1,250MHz. These components are sitting on top of the Asus Rampage V Extreme motherboard, which is the same mobo we used in our Dream Machine. All of this is then powered by a 1,200-watt Corsair PSU. For cooling, the Shift uses a crazy large 18cm AIO CPU cooler, which we've never seen before. This, of course, is supplemented by another 18cm chassis fan. These mean this machine is truly spinnin' on 18s. For storage, the system uses two 250GB Samsung 850 EVOs in RAID 0, coupled with a 3TB Seagate Barracuda for mass storage.

When it was time for the Shift to shift into high gear, it smoked our zero-point in just about every race. With its 4.5GHz NOS-fueled overclock, it outran our ZP's 5960X by 11–20 percent in our CPU tests. In the GPU tests, it ran laps around our ZP's three 980s, besting it by 54–93 percent!

We're sure there are lots of enthusiasts who can build nice PCs, but most of them can't build one this nice. For starters, the case isn't for sale separately. On top of that, the paint job and cable management are truly professional-grade. At $6,500, it's a very expensive system, but you're getting very expensive parts, handcrafted with love. We aren't saying there isn't a premium for this love, but it's actually a pretty fair deal when you itemize everything. The Shift does have its flaws, but they're minor, whereas the Shift's strengths are mighty. At the end of the day, this is definitely one fast and furious rig. –**JIMMY THANG**

VERDICT
9
KICK ASS!

Maingear Shift

➕ **FAST** Beautiful; powerful; stays cool and quiet; impeccable paint job.

➖ **FURIOUS** No custom cooler; having to remove top lid is quite annoying; no underglow.

$6,500, www.maingear.com

SPECIFICATIONS

Processor	Core i7-5960X @ 4.5GHz
Mobo	Asus Rampage V Extreme
RAM	16GB DDR4 3,000MHz
Graphics	3x GeForce GTX 980 Ti in SLI
Storage	2x 250GB Samsung 850 EVOs in RAID 0, 3TB Seagate Barracuda
Optical	Blu-ray burner
Case	Maingear Shift
PSU	Corsair 1200

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	806	668 (20.7%)
Proshow Producer 5 (sec)	1,472	1,298 (13.4%)
x264 HD 5.0	33.8	37.8 (11.8%)
Batman Arkham City GOTY (fps)	204	286 (40.2%)
Tomb Raider (fps)	87.5	149 (70.3%)
3DMark Firestrike	8,016	12,366 (54.3%)
Shadow of Mordor (fps)	70.1	135.3 (93%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-5960X CPU, three GTX 980s, and 16GB of RAM. *Arkham City* tested at 2560x1440 max settings with PhysX off. *Tomb Raider* at Ultimate settings. *Shadow of Mordor* at Max settings.

The left touchpad is hardly ever used for movement.

Steam Controller

How I learned to stop complaining and appreciate the controller

WORD ON THE STREET is that the Steam Machines were delayed because the Steam Controllers weren't ready. After using the device for several days, we think it has tremendous potential, but we think Valve took it out of the steamer a little too early.

The first thing you'll notice is that it's as weird as hell. It has two circular touchpads on the front, yet it still has a left joystick and four Xbox-style face buttons pushed down toward the center-bottom. Some people are dismayed by the smaller buttons and the placement of these traditional inputs, but they didn't bother us much.

What was initially bothersome were the touchpads, which offer varying levels of haptic feedback. Unlike the Xbox One controller, which has concave grips, the largely plastic Steam Controller has convex sides, which lead your thumbs to the center of these oddities. Suffice it to say, the touchpads have a steep learning curve and will probably take you hours to get comfortable with. If you're willing to put in the time to get used to the controls, however, you might be able to tap into the controller's true potential. That's not to say it's perfect, but we'll discuss that later.

On top of the controller are four shoulder buttons—the bigger pair offers dual-stage triggers— and there are two customizable paddle buttons on the back, which are a welcome addition. Front and center of the controller are buttons for start, select, and Steam Big Picture mode. The SBP button is also the gateway to configuration, and it enables you to force-quit out of games.

Speaking of configuring your controller, because it was designed to be backward compatible with the entire library of Steam games, Valve is relying heavily on the community to make custom game presets. The highest-rated community-made preset will be the default control scheme for each game. While this sounds great in theory, at the time of writing, many games either lack presets or the ones they have are garbage. For instance, there are community-made presets for shooters that have no movement controls. In addition, the touchpads can act differently from preset to preset. We're not just talking about sensitivity, though that varies greatly, but sometimes the trackpad is programmed to emulate a joystick, trackpad, mouse, or trackball. It's like a box of chocolates—you never know what you're going to get.

Luckily, there are generic presets that you can choose from to emulate a standard Xbox controller or mouse/keyboard combo, but sometimes these presets don't allow you to navigate game menus, and you have to switch back and forth between presets. This feels really janky.

TEAM EFFORT

To be fair, pretty much all of our testing was done before the community at large got their hands on the controller, but as of now, Valve doesn't even have presets for its own games. *Team Fortress 2,* for instance, handles well using the default, generic controller input, but it doesn't have buttons to switch characters or classes. The Rockstar-supplied *GTA V* preset is damned near unusable when it comes to shooting.

Thankfully, you can tweak just about everything with the controller. The dizzying array of customization options may well be overwhelming for many. The modding community will definitely get a kick out of it, but we suspect many more casual gamers will be intimidated by the process.

Once you get the controller working, however, it really flies. Some people are of the opinion that Valve is trying to fix a problem that doesn't exist, but we don't subscribe to that notion. Trying to use an Xbox controller against a keyboard/mouse user is like bringing a knife to a gunfight. While the Steam Controller will never replace the keyboard/mouse combo in our eyes, it at least closes the gap. In *Counter Strike,* we were able to press down on the right touchpad on a user-created preset to go in for tighter headshot controls that felt way more accurate than an Xbox controller.

We imagine that the Steam Controller has the potential to age like a fine wine once more of the community gets their hands on it, but we unfortunately can't review a device based on potential. As it is right now, the controller will allow you to get more headshots in if you've got the patience to tame its wildness, but if you're not into the tweaking scene, we suggest you hold off until more user presets are made and the bugs are steamed out. **–JIMMY THANG**

VERDICT **7**

Steam Controller

+ STEAMY Easier to get headshots than with Xbox controller; comfortable to hold; touchpad support for mouse menus.

– GASSY Steep learning curve; crowd-sourced presets are a mess; controller ecosystem feels jerry-rigged.

$50, http://store.steampowered.com

Future

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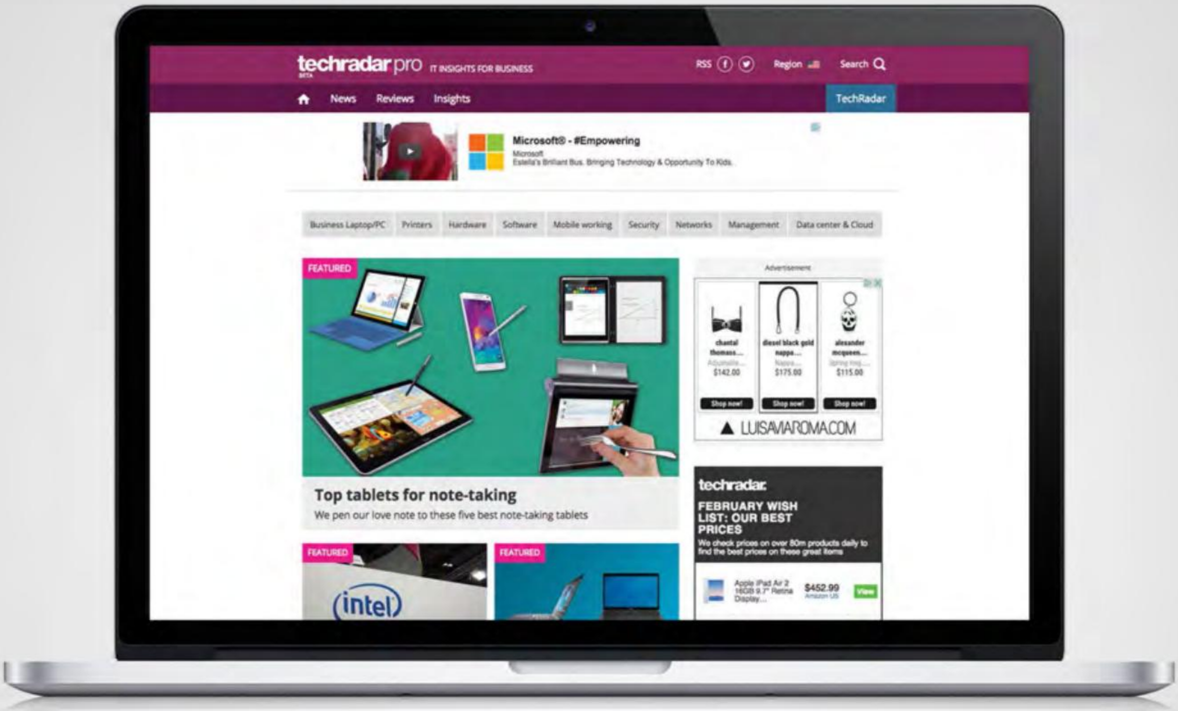
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Steam Link

Wireless connections need not apply

IN CASE YOU ALREADY have a capable gaming PC, and don't want to pony up cash for an expensive Steam Machine for your living room, Valve has made an affordable device for you. The company calls it the Steam Link, and it's a passport-sized peripheral that allows you to mirror games from your desktop PC using Steam's In-Home Streaming feature.

In terms of tech specs, the Steam Link supports HDMI for a 1080p/60Hz output to your HDTV. The little box measures 4.8x3.6x0.7 inches, and other connections include power, 100Mb/s Ethernet, and three USB ports. We would have preferred four USB ports for more wired controllers, but the Steam Link does enable you to connect up to four Steam Controllers without need for any USB dongles, and the device also plays nicely with USB hubs. Underneath the hood, the Link supports Bluetooth 4.0 and wireless 802.11ac, along with your standard b/g/n variants.

Setting up the Steam Link is easy. As it says on the product page, you simply need to "connect your Steam Link to your TV and home network, where it will automatically discover any computer running Steam." While it works best with the separate Steam Controller (see page 76), we've also been able to hook up Xbox 360 controllers, Xbox One controllers, and even a keyboard and mouse to it. Oddly enough, it didn't play nicely with Microsoft's new Xbox Elite controller or its wireless dongle, but that can be forgiven, because they're so new.

How does it perform? Sadly, if you go down the wireless route, not well. We were initially thinking of providing you with a benchmark chart tabulating distance from router and latency, but decided instead to just cut to the chase: The Link really shouldn't be used wirelessly—in our experience, it's that bad. We'd say anything under 50 milliseconds of latency is fine, and while the Link was able to stay under that for most of our wireless time with it, the compression, audio drop-offs, and lag spikes just killed it, even when we were just a dozen or so feet away from our Asus RT-N66U router in the next room.

DOWN TO THE WIRE

Here, the lag would shoot up to over 400 milliseconds on occasion. We tried playing around with all the latency settings, but nothing we did resolved the issue. The experience is better when you have the device right next to the router, but even then, we experienced weird issues where it kicked us out to our PC's desktop menu. When we tried to open Steam Big Picture mode again using the Steam Controller's mouse emulation, it launched us back into the game that was already in progress, but shifted commands from our controller to our desktop's keyboard. That's not good. To be fair, even Valve says on its product page that a "wired network is strongly recommended," but a lot of people don't have Ethernet strewn about every room in their homes. Valve should have implemented an external antenna on the Link to extend its range.

When you go down the wired route, the situation improves dramatically, but it's still not perfect. We experienced lower latency, hovering around the 20 milliseconds range, which is perfectly playable. We also set streaming quality to Beautiful, and compression wasn't an issue either. Because it's streaming from your gaming PC, it brings some unwanted features along with it. For instance, we had an antivirus update prompt pop up on our desktop and this caused the Steam Link to freeze, and we had to go back to our computer to close the offending message. The Link also pumps unwanted noise over from the desktop, so expect to hear things such as chat notifications or other sounds that your PC produces. Plus, games that load in Windowed mode look pretty funky, and sometimes you'll see your row of Windows taskbar icons below.

The Steam Link is supposed to deliver an elegant and seamless streaming experience, but we still see a lot of dirty laundry that Valve wasn't able to tuck away in its current state. At $50, it's unlikely to break the bank, but we still really only recommend it for those who can use the wired option. Even then, don't expect a perfect experience just yet. –JIMMY THANG

VERDICT
7

Steam Link

+ WIRED CONNECTION Affordable; can connect multiple controllers to it.

− WIRELESS CONNECTION Wireless is awful; lots of bugs at the moment.

$50, http://store.steampowered.com

Zotac GTX 980 Ti Amp! Extreme

Caution: wide load!

REMEMBER WHEN graphics cards were called video cards, spat out a whopping 256 colors (or 16 or even 4 colors/monochrome if you go back far enough), and occupied a single expansion slot? Sure, smaller cards continue to exist, but it's been roughly a decade since halo GPUs launched in single-slot variants. Today, just about every GPU in the mid-range or higher performance bracket occupies two expansion slots.

This has all been done in the name of keeping things cool and quiet, as larger heatsinks and fans make it easier to keep temperatures and noise in check. And considering that the latest GPUs can

Zotac's GTX 980 Ti Amp! Extreme dwarfs all other GPUs; we nicknamed ours Gargantuar.

require up to 275 watts, that's no mean feat. Zotac takes things one step further, with its triple-wide GTX 980 Ti Amp! Extreme. There's only one question: Does the added bulk improve performance? In a word, yes.

If you want only a single GPU and the fastest factory clock around, Zotac wins that contest by providing a 25 percent GPU overclock, which is higher than we were able to push our reference 980 Ti card. Zotac also bumps the GDDR5 clocks up three percent, making it one of the few 980 Ti cards to ship with overclocked RAM.

Looking at the size of the cooler, the RAM overclock seems tame. This is a monster cooler waiting to be pushed to the limit, and the factory clocks leave some untapped potential. We pushed the fan speed up to 100 percent and managed to run through all of our gaming benchmarks with settings of 1300/8250, +87mV bump to voltage; GPU Boost is still enabled, which results in GPU clocks closer to 1,450MHz. Now, that's an overclock worthy of three slots!

MONSTER GPU MADNESS

Even with the factory clocks, Zotac takes the performance crown in all of our benchmarks. It beats the stock-clocked 980 Ti by 14 percent on average, or the stock GTX Titan X by 12 percent. With additional overclocking, we're able to tack on another eight percent. Cycling through our games doesn't affect things; with dirt spewing from its oversized tires, Zotac's monster truck of a GPU crushes the competition flat.

One thing we've learned recently with the release of the *Mad Max* video game is that, when the world ends, having the biggest, brawniest engine possible will be the difference between life and death. Max would definitely appreciate Zotac's GPU, and he'd use it to set his enemies on fire. The only real issue with the Zotac card is its size, which requires not just three slots but 12.5 inches to fit the card into your case. Needless to say, there are plenty of standard ATX cases that won't have room for the Amp! Extreme, though most full-size ATX cases should be OK—make sure the card will fit before buying. Power requirements are also higher, and we recommend having at least a 750W PSU to be safe, but those are readily available.

Zotac's beastly GPU is the antithesis of AMD's R9 Nano (October 2015, p.72). Where AMD's engineers targeted making the smallest GPU possible, Zotac wonders how big enthusiasts are willing to go. This is the fourth time the company has trotted out its supersized cooler, which indicates there's enough of a market niche here that it's worth the effort. Nvidia's GTX 980 Ti is most definitely Kick-Ass hardware, and that applies to all of the 980 Ti cards we've looked at so far. The Amp! Extreme will be more GPU than many people need or even want, but if you have space in your case, and you only intend to use a single GPU (or at most two), short of liquid cooling, it wins for out-of-box as well as overclocked performance. **–JARRED WALTON**

VERDICT
9
KICK ASS!

Zotac GTX 980 Ti Amp! Extreme

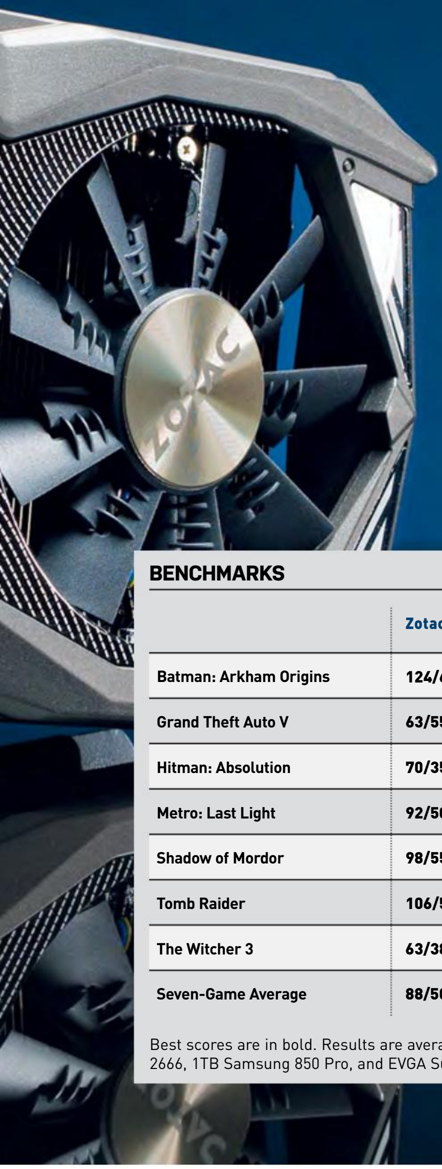
➕ **BIG FOOT** Awe-inspiring performance; massive overclocks; great cooling.

➖ **SMART CAR** Pricey; requires lots of space; higher power requirements.

$680, www.zotac.com

SPECIFICATIONS

GPU	GM200
Lithography	28nm
Transistor Count	8 billion
SMMs	22
Shaders	2,816
Texture Units	176
ROPs	96
Core/Boost Clock	1,253/1,355MHz
Memory Capacity	6GB
Memory Clock	7,220MHz
Bus Width	384-bit
Memory Bandwidth	346.5GB/s
TDP	258W



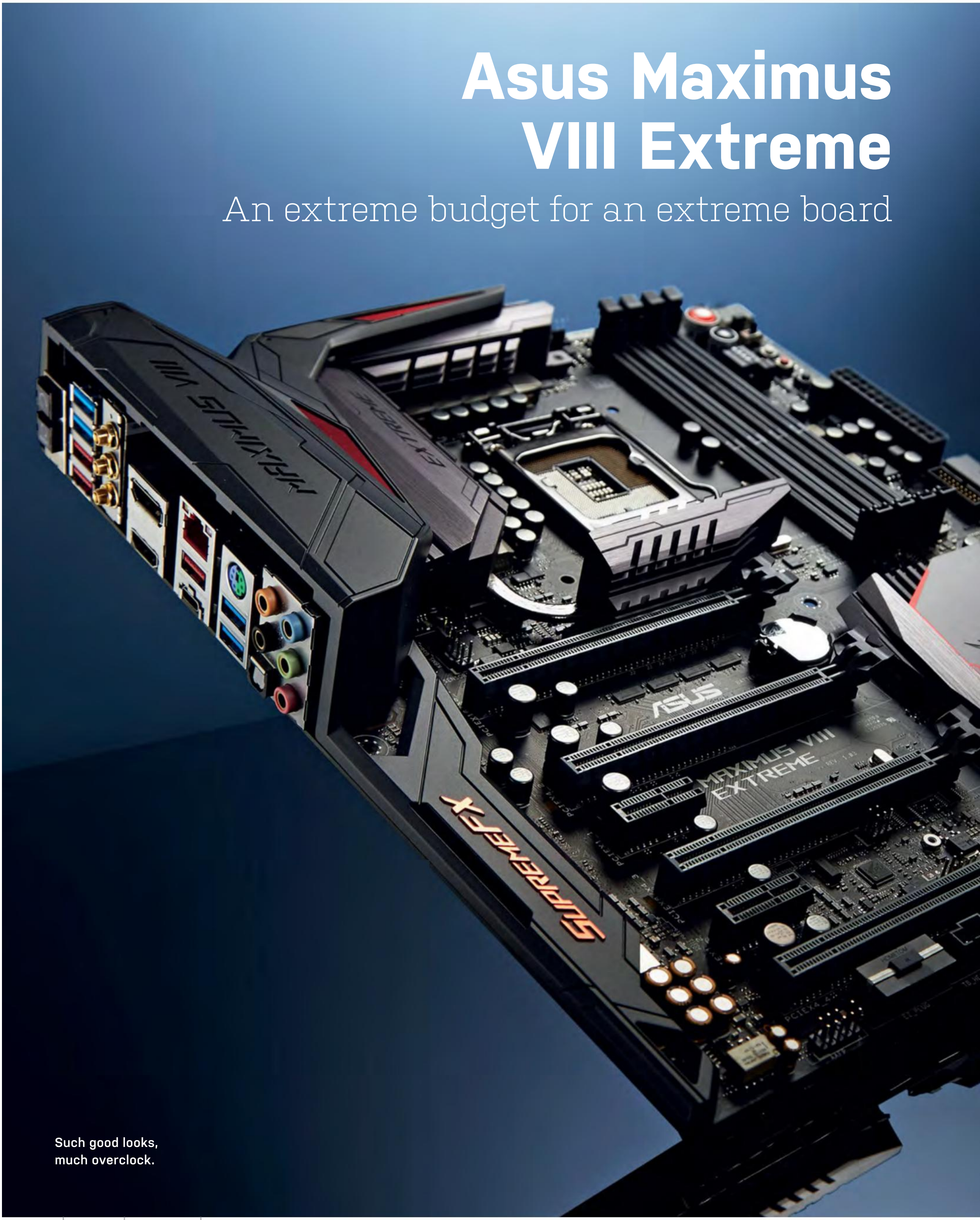
BENCHMARKS

	Zotac 980Ti	**GTX Titan X**	**GTX 980 Ti**	**R9 Fury X**	**R9 Fury**	**GTX 980**	**R9 Nano**
Batman: Arkham Origins	**124/61**	114/54	112/54	114/57	108/54	85/42	102/51
Grand Theft Auto V	**63/55**	58/49	58/49	49/46	46/42	46/39	46/40
Hitman: Absolution	**70/35**	64/33	64/33	67/36	63/34	50/25	61/33
Metro: Last Light	**92/50**	81/44	80/44	70/39	64/35	67/36	61/33
Shadow of Mordor	**98/55**	85/48	84/48	81/48	77/44	69/39	74/42
Tomb Raider	**106/53**	92/47	91/45	85/44	75/39	75/37	72/37
The Witcher 3	**63/38**	54/33	53/32	49/31	45/28	44/26	43/27
Seven-Game Average	**88/50**	78/44	77/43	74/43	68/40	62/35	66/37

Best scores are in bold. Results are average fps at 1440p/4K. Our test bed is a 4.2GHz overclocked Core i7-5930K in a Gigabyte GA-X99-UD4 motherboard, with 4x 4GB DDR4-2666, 1TB Samsung 850 Pro, and EVGA SuperNOVA 1,300W G2, running 64-bit Windows 8.1.

Asus Maximus VIII Extreme

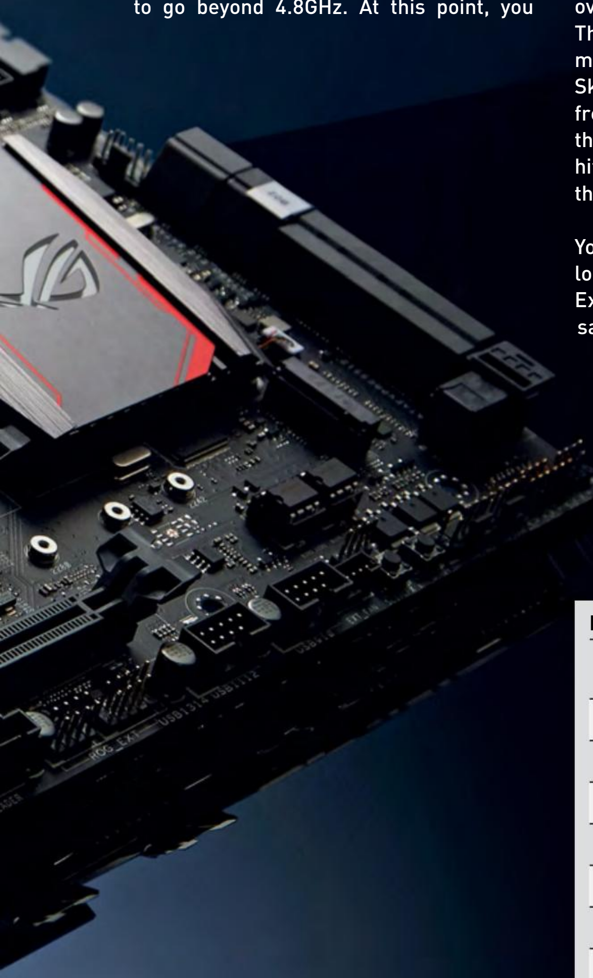
An extreme budget for an extreme board


MAXIMUS VIII
EXTREME
ASUS
MAXIMUS VIII
EXTREME
SUPREMEFX

Such good looks, much overclock.

LET'S BE CLEAR HERE. We understand not everyone is into overclocking. It can be a daunting, possibly bank-breaking pastime, with the potential to take your hard-earned hardware and render it as useful as sunglasses in a thunderstorm. That being said, for those who are looking for the absolute pinnacle of Skylake mobos, those who want the very best overclocking potential, regardless of cost, the Asus Maximus Extreme series should be your first port of call.

When we test products—motherboards in particular—we have one specific benchmark that they all need to hit. And more often than not, we are always limited by one common problem: the silicon lottery. Before this, we believed that our Intel Core i7-6700K was limited to 4.8GHz, and no matter what we tried, messing around with every setting and voltage under the sun, we could never surpass that. Even Asus's RoG Maximus VIII Hero failed to go beyond 4.8GHz. At this point, you can probably guess what happened next. With just a few small tweaks—one to the ratio, and one changing the TPU setting in Asus's very fluid UEFI BIOS—we managed to grab ourselves a stable 4.9GHz on top of successfully completing a full round of benchmarks on Cinebench R15.



SKYNET A REALITY

Rather worryingly, this wasn't the scariest part of our experience with the Maximus VIII Extreme's overclocking abilities. After enabling Asus's 5-Way Optimization software in AI Suite, it managed to overclock itself to 4.85GHz with relative ease. Undoubtedly, this means we're one step closer to Skynet. After all, if machines can overclock themselves, what's stopping their inevitable rise to power and our mutual annihilation?

It seems as though the Extreme wasn't entirely finished there either, as it wasn't the silicon preventing an even higher overclock, but the chip's temperature. There's almost no doubt that if we had a more powerful cooling solution, our little Skylake CPU could hit that glorious 5GHz frequency with no problems. It's a shame that the NZXT Kraken X61 just couldn't quite hit the mark when it came to managing those CPU-punishing temperatures.

To be fair, this is a $500 motherboard. You'd expect it to perform well. But if you're looking for something extra, the Maximus Extreme has oodles of other features to satisfy your glorious PC gaming appetite.

In addition to the plethora of microfine alloy chokes, 10K black metallic capacitors, and fancy MOSFET solutions, the Extreme comes with the same audio solution as found on the Maximus Hero. Of course, you still get everything AI Suite has to muster. And on top of that, you're graced with wireless AC and Intel's network traffic management. But that's not all—there's an overclocking panel, a plethora of temperature monitoring points, and even a fan controller expansion card included in the rather large box.

Does that warrant the price? Sort of. If overclocking isn't a priority, but you want to stick with Asus, grab yourself a Maximus VIII Hero—it's still a fantastic motherboard, looks great, and features all the same gaming-oriented specs of the Extreme, bar the heavy overclocking stuff. If you want something smaller (again presuming you want to stay with Asus), the Gene or the Impact is probably going to be your jam. If you're not really a gamer but rely on solid dependability, you might want to take a look at the TUF Sabertooth line-up instead. But for that minority of focused overclockers, this is as good as it gets. **–ZAK STOREY**

VERDICT
9

Asus Maximus VIII Extreme

+ GLADIATOR Great overclocker; looks great; RGB lighting; 802.11ac; quality auto-overclocking; front bay panel.

– LES MISERABLES Price; won't run four graphics cards.

$499, www.asus.com

SPECIFICATIONS

Chipset	Intel Z170
Socket	LGA 1151
Form factor	EATX
Memory support	DDR4/3866
Storage	8x SATA 6Gbps, 1x M.2, 2x SATA Express, 1x U.2
USB	6x USB 2.0, 8x USB 3.0, 3x USB 3.1 Type-A, 1x USB 3.1 Type-C

BENCHMARKS

	Asus Maximus VIII Extreme	**MSI Z170A Gaming M7**
Cinebench	907	**923**
X264 V5.0.1	**20fps**	**20fps**
Memory Bandwidth	29GB/s	**30GB/s**
Shadow of Mordor 4K	**27fps**	**27fps**
PCMark Score	4,559	**4,820**
Maximum Overclock Achieved	**4.95GHz**	4.8GHz
Cinebench @ OC	**1,035**	1,026
Power Draw Idle/Peak	**56W**/355W	84W/**318W**

Best scores are in bold. Both boards tested with an Intel Core i7-6700K, Nvidia GeForce GTX 980, and 16GB of DDR4/2666 RAM.

Impossible to write a caption.... Mic too pretty.

Razer Seiren Pro

The streamer's dream mic?

WELL, WELL, WELL, we may as well face it—streaming is here to stay. If you head over to Twitch, you'll see thousands of streamers, companies, and YouTubers merrily selling their subscriptions and unadulterated content to the masses, open for all to see. Hell, we do it, so why shouldn't you?

But what happens if you want to take that first plunge into the digital stream? Dipping your little toe into the icy waters of Internet fandom? Well, you need to get yourself a solid PC, ideally something with at least four cores, 16GB of RAM, and one or two meaty graphics units from your favorite team (green or red, we won't judge).

Then, of course, if you want to add your ugly mug to the mix, you need to acquire a webcam, slim pickings admittedly—presumably a Logitech at this point in time. And, finally, a high-quality recording device. You could get away with a headset mic but, damn it, this is *Maximum PC.* You want the best, and that's what we're bringing you. Crystal clear, studio-grade, high-fidelity sound. Say "hello" to the Razer Seiren Pro.

This isn't Razer's first foray into dedicated microphones. Since the launch of the first Seiren in December 2014, Razer has made some improvements on the Seiren Pro. One of them being the dedicated five-pin XLR output, and a fancy gizmo called the high pass filter.

But where this product shines is the overall feel and quality of the build. This is exactly what Razer should be making, and it's spectacular. From every angle, you're greeted with a beautiful matt black dedicated microphone setup, complete with refined silver accents around the center of the minimalistic design. Even the green triple-headed snake emblem forsakes the usual color scheme in favor of platinum detailing. The basic stand (if you can call it that) consists of a powder-coated black aluminum base, on top of a velvet, non-slip pad with two tightening pivot points at the middle of the microphone.

AUDIO FIT FOR KINGS

It's just a mic, though, right? Surely, what's most important here is the audio? Well, it's a good thing Razer has you covered here as well. From raw recordings, we found the sound to be crisp and smooth. Activating Razer's high pass filter eliminates any unwanted bass from your recordings, giving a well rounded clarity to your voice. It also gets rid of any low-lying noise or vibrations from the surrounding area—say "goodbye" to PC hum. On top of that, you get four different recording patterns. Between cardioid, omnidirectional, stereo, and bidirectional, Razer ensures that no matter what your setup—whether you're jamming out tunes, recording a solo podcast, or interviewing your roomie—you'll always get the sound you're after.

So it's just like a fancy-looking Blue Yeti, then? Well, sort of. It extends far beyond that, though. And if you want more, Razer can supply it. Want to add a shock mount? Sure thing. Need to attach it to a boom? Yep, done. Need a pop filter? Yeah, we've got that, too. Direct 0 latency headphone monitoring? Not a problem. Need an LED display and a mute button? Sure, we can do that.

You get the point. There's nothing this mic can't be set up to do. Razer really has nailed it. This is the perfect all-round microphone. It looks stunning, the audio is fantastic, and if you're looking for a classy, solid, dependable mic, the Seiren Pro is the one for you. Don't believe us? Check out the raw recording we did at http://bit.ly/MPCSeirenPro. **–ZAK STOREY**

VERDICT
9
KICK ASS!

Razer Seiren Pro

+ **ODYSSEUS** Beautifully crafted; fantastic quality; huge feature set; diverse recording patterns; 192kHz sample rate; looks stunning.

− **PERCY JACKSON** Pop filter and shock mount bought separately; hard to see LED display; pricey.

$250, www.razerzone.com

SPECIFICATIONS

Recording Patterns	Cardioid, stereo, omnidirectional, bidirectional
Sample Rate	192kHz
Bit Rate	24-bit
Frequency Response	20Hz–20kHz
Capsules	Three 14mm condenser capsules
Connectivity	USB and XLR

BenQ GW2765HT

This will take some beating

CHOICE IS A FINE THING. But in this modern age of economic plenty, it can also be paralyzing. The PC monitor market is a case in point. Right now, you can choose from all manner of screen resolutions up to 4K. Actually, you can even go beyond that, with 5K screens available of late. Or how about a monitor with an ultra-wide panel? Or a curved surface? Or support for stereoscopic 3D? While you're at it, what about high refresh of 120Hz or more? And don't forget you'll want that refresh perfectly synched with your GPU's output.

Once you've sorted all that out, you'll also need to choose a panel type. You know: IPS, TN, or even VA. Also, have you decided whether you need a fully adjustable stand? You get the point. It's almost too much choice. And even if you can afford to take your pick from everything above, there isn't a monitor currently available that combines the best bits of everything.

Which brings us to the new BenQ GW2765HT. It's not exactly cutting-edge in any area. But it might just be about as good as it gets in the real world right now. Allow us to explain.

RESOLUTION REVELATIONS

4K resolutions and beyond are seriously seductive. But you'll struggle to drive them properly in games. Too many pixels, you see. The BenQ has 2,560 by 1,440 pixels. Enough for decent desktop screen real estate, and great in-game detail, but not so much it overwhelms your GPU.

Likewise, at 27 inches it'll satisfy most people's need for sheer scale of image. It also has a fully adjustable stand. Oh, and here's the kicker—it has a proper IPS LCD panel. None of your poverty-spec TN stuff going on here. All for well under $400, and from a big brand, as opposed to some obscure Korean thing sourced from a sketchy eBay dealer. Nice.

What you don't get is high refresh or frame synching technology. That's a pity for games, especially the high refresh bit. But the fact is, IPS 27-inchers with high refresh support are both rare and very pricey. Something has to give at this price point.

If you can get over that little hump, what you'll find is a delightful panel. Fire it up and you're instantly in no doubt that this is a quality IPS item. The colors are both super vibrant and immediately accurate.

It's nicely calibrated out of the box, too. Both the black and white scales are pretty much faultless. The anti-glare coating is nice and smooth, too. None of that old-school twinkle. Speaking of traditional IPS downsides that have apparently disappeared, you'll struggle to pick up on any of that annoying IPS glow in dark tones. The latest IPS panels have dialed it out.

As a gaming panel, it's not bad, either. There are four levels of pixel response available from the overdrive menu. You can switch overdrive off, or choose from one of three enabled settings. The middle setting jazzes up the response without introducing inverse ghosting ugliness.

If you insist on teasing out some shortcomings, well the backlight is very, very slightly yellow, and the integrated speakers are feeble and tinny. The chassis and stand are pretty plain looking, too.

Overall, then, it's a very nice package for the price. If you've seen high refresh and simply cannot live without it, fair enough. For everyone else, this BenQ will take some beating. –**JEREMY LAIRD**

VERDICT **8**

BenQ GW2765HT

⊞ **OSCAR-WORTHY** Lovely 27-inch IPS panel; really well calibrated; fully adjustable stand.

⊟ **GOLDEN RASPBERRY** No high refresh technology; no frame synching; is 27 inches a bit puny?

$380, www.benq.com

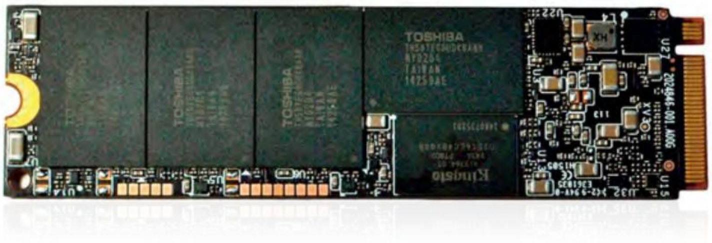
SPECIFICATIONS

Panel Size	27-inch
Native Resolution	2560x1440
Panel Type	IPS
Contrast	1,000:1
Response	4ms
Inputs	DP, HDMI, VGA, DVI
VESA Mount	100x100

HDMI
senseye3
LED

Sometimes it's evolution that produces the goods.

GW2765
BenQ



Kingston HyperX Predator NVMe

Impressive endurance, moderate performance

WITH ALL THE HULLABALOO about M.2 PCIe NVMe SSDs, users of older systems might feel left out. Enter the Kingston HyperX Predator, with an optional half-height, half-length (HHHL) adapter card that allows anyone with a spare PCI Express slot to use an M.2 drive. There's nothing revolutionary about the card—it just converts up to four Gen3 PCIe lanes into an M.2 connector—but it opens the M.2 doors to virtually any recent desktop. The catch is that you won't be able to use an NVMe SSD as your OS/boot drive unless your BIOS supports NVMe—it will work in Windows as a secondary drive, but potentially you'd have a slower SATA SSD as the OS drive.

One impressive statistic on the Predator is the endurance rating. Kingston specs this 480GB model at a whopping 882TB total bytes written, which equates to 1.7 drive writes per day (DWPD). Even the heaviest of home users is unlikely to be writing 800GB of data on a daily basis, so it's highly unlikely anyone will be burning through all the NAND cycles. We have to temper the high endurance rating with a less impressive three-year warranty, however. Samsung's 950 Pro by comparison has less than half the endurance rating but carries a five-year warranty. Not that the warranty from either company will help too much if your drive fails and you lose data, so make sure you have a good backup strategy.

TAKE THIS BROKEN WING

With the SATA bottleneck out of the picture, M.2 SSDs can stretch their wings and fly... at least to the limit of their abilities. This is where the Predator runs into problems. It's using a Marvell controller and is rated at up to 130K/118K IOPS max read/write performance in IOmeter—interestingly, the 240GB model carries a higher 160K/119K IOPS rating, suggesting the controller may not be fully optimized for larger capacities. While those numbers look good compared to any SATA drive, they fall far short of the 300K/110K IOPS rating of Samsung's 950 Pro 512GB SSD, and sequential read/write speeds are also much lower.

Our benchmarks confirm that the ratings are perhaps overly generous as well; we measured 109K read IOPS but only 60K write IOPS in AS SSD. In general, the Predator delivers about half the maximum performance of the 950 Pro. That wouldn't be so bad, were it not for the fact that the 950 Pro is targeting a lower price point than the Predator. Another comparison not shown in our table is that two Samsung 850 EVO 250GB SATA SSDs in RAID 0 run neck and neck with the single Predator, often beating it in random IO workloads.

This just goes to show that using the latest buzzwords as a basis for your next buying decision can lead to disappointment. The Predator has actually been out for a while, and it was the very first M.2 NVMe SSD to hit the market. Unfortunately, while it's generally faster than any individual SATA drive, the Predator falls well short of the potential that M.2 NVMe offers. The Intel SSD 750, Samsung SM951, and Samsung 950 Pro all easily surpass the performance of the Predator, and they do so without carrying a substantial price premium. **–JARRED WALTON**

BENCHMARKS

	Kingston HyperX Predator 480GB	Intel SSD 750 1.2TB	Samsung SM951 256GB	Samsung 950 Pro 256GB	Samsung 850 Pro 1TB
AS SSD Sequential Read/Write	1,008/743	**2,362/1,320**	1,973/1,155	2,063/901	525/496
AS SSD Random Read/Write	39/92	36/**205**	49/140	**52**/160	29/76
AS SSD QD64 Random Read/Write	446/247	**1,446/1,041**	1,105/338	1,021/254	380/279
IOmeter Mixed Read/Write Sequential	580	**1,605**	1,200	1,008	502
IOmeter Mixed Read/Write Random	84	**454**	350	267	177
File Copy (20GB)	429	564	**629**	560	242
PCMark 8 Storage Score/Bandwidth	5,010/324	5,069/511	**5,092/654**	5,089/622	4,987/284

Best scores are in bold. All figures except PCMark 8 Score are in MB/s. The test platform consists of an Intel i7-6700K processor, Asus Z170-A mobo, and 2x 8GB G.Skill DDR4-3000.

VERDICT

7

Kingston HyperX Predator NVMe

➕ **GREAT FIND** Faster than SATA; high endurance; HHHL adapter for older systems.

➖ **NEVER MIND** Not as fast as other NVMe offerings; expensive; short warranty; requires NVMe BIOS support to use as a boot drive.

$450, www.kingston.com

SPECIFICATIONS

Interface	M.2 PCIe x4 Gen3
Form Factor	M.2 2280 (optional HHHL adapter)
Capacity	480GB
Controller	Marvell 88SS9293
Memory Type	Toshiba A19 Toggle NAND
Max IOPS Read/Write	130,000/118,000
Endurance	882TB/1.7 DWPD
Warranty	Three years

Razer Mamba

RGB LEDs in a wireless mouse?

EARLIER IN 2015, Razer launched the Tournament Edition spin of this psychedelic explosion of 16.8 million colors. Building on the 2014 edition of the famed Mamba, the TE featured a brand new Philips 16,000 dpi sensor, coupled with absolute control over your sensitivity settings using single dpi increments, and up to five separate dpi profiles. Unlike the previous edition, the TE variation also came cabled, which was no doubt in part to reduce the frustration of running out of juice midway through a firefight, and having to swap over to the cable mid-game.

Just a few months later, and huzzah! We're witness to the launch of the full-fledged Mamba in all its shiny glory. On top of the new additions found in the TE version, Razer has added an adjustable button tension setting, providing users with the ability to tweak how high they want their button clicks to register. In reality, the difference is very minor, and if you do notice the difference, there's no quantitative way of measuring how tight or loose your tensions were if you ever reset them. Of course, with this brand new Mamba, you also get the joy of wireless connectivity, but in comparison to the TE edition, that's pretty much it.

THE PREMIUM FEEL

Overall, the mouse looks great—the sandblasted black finish on top of the device lends itself to discouraging greasy finger marks, as opposed to its soft-finished competitors. The RGB strips are clearly visible, and the rubber thumb and finger grips on either side of the mouse provide great support for the palm grip users out there.

That said, in our opinion, losing out on the soft-touch finish takes away part of the premium quality that satin finishes can bring to a device. Compare the Mamba to the Corsair Sabre or the Steelseries Rival, and it's not as pleasing to hold—it feels abrasive under your digits. The Mamba still carries quite a bit of heft to it, though, no doubt in part to the 500mAh battery at its heart, but overall that's not necessarily a bad thing. If anything, the Mamba TE felt a little light, weighing in at 0.2lb (not including the cable), compared to the Mamba's full 0.3lb. It lacked that sturdy feeling you get when using a heavier mouse. There's almost a kind of confidence you develop from a heavier mouse, like a well-balanced sword resting in the palm of your hand.

As far as tracking goes, we found the new Mamba to be a solid and dependable mouse, in our experience at least. We had very little trouble with wireless tracking or precision either—however, there are definitely mutterings online concerning potential software processing issues, which is something that wireless mice are still notorious for. If you're a little wary, you might want to give some thought to whether you really want to fork out for this, or whether you should plump for the wired edition instead.

On top of that, due to those lovely little multicolored LEDs, you don't get anywhere near as much battery life as you do from some of the other wireless alternatives out there. You'll need to ensure you place it back on the dock overnight.

If you are caught in a pinch without enough juice to power this mini beast, Razer has retrofitted the docking cable to provide power to the mouse as well. We did have trouble swapping it over to cable mode, though. This mostly seemed to be down to a conflict between Corsair's Utility Engine and the K70 RGB keyboard we use on our test bench. Razer has assured us that its working on identifying whether this was an issue with our particular Mamba, or the tech and software we were using in conjunction with it, and have promised to get to the bottom of it, but until then, it's another thing to bare in mind.

Ultimately though, the Mamba is a fine piece of hardware. It has a few niggles, but then, most wireless mice do. The RGB LEDs do feel a little pointless, and certainly don't contribute to any aspect of your gaming performance. But otherwise, the fact that Razer continues to innovate in areas like this is a very good sign. It boils down to the following: Are you willing to risk wireless tracking issues, and are you going to charge it every night? If the answer is no, you might want to opt for the Mamba TE instead. –ZAK STOREY

VERDICT

8

Razer Mamba

⊞ **DEADLY SERPENT** RGB lighting; responsive; adjustable click-force tension; Razer Synapse UI; on-screen dpi indicator; single-step dpi increments.

⊟ **WIGGLY WORM** Abrasive finish feels lackluster; possible wireless tracking issues; non-removable battery.

$150, www.razerzone.com

SPECIFICATIONS

Sensor	Laser
Max Sensitivity	16,000 dpi
Programmable Buttons	9
Weight	0.3lb
Cable Length	7 feet

NP9778-S Notebook
$2,299

After $160 Instant Savings

- 6th Generation Intel® Core™ i7-6700K Processor (8MB Smart Cache, 4.0GHz)
- Windows® 10 Home 64-bit Edition
- 17.3" Full HD IPS Matte Display (1920x1080) with NVIDIA® G-SYNC Technology
- 30 days No Dead Pixel Guaranteed Insurance
- 8GB DDR5 NVIDIA® GeForce™ GTX 980M GPU
- Opt. NVIDIA® Quadro® M3000M / M5000M GPU with model NP9775
- 16GB Dual Channel DDR4-2133MHz Memory
- 250GB Samsung 850 EVO M.2 SSD + 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives or 2 M.2 PCIe SSD Drives capable
- Hardware Raid 0,1 Function capable
- Full sized Keyboard with color LED backlight
- Killer™ DoubleShot™ Pro (Killer E2400 LAN + Killer Dual Band Wireless-AC 1535) with Smart Teaming
- USB 3.1 / Thunderbolt Gen3 Combo Port
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Built-in Onkyo Hi-Fi speakers and a sub-woofer
- Sound Blaster® X-Fi™ MB5 Sound System

NP9758 Notebook
$1,999

FREE UPS GROUND SHIPPING*

- 6th Generation Intel® Core™ i7-6700 Processor (8MB Smart Cache, 3.40GHz)
- Windows® 10 Home 64-bit Edition
- 15.6" Full HD IPS Matte Display (1920x1080) with NVIDIA® G-SYNC Technology
- Opt. 15.6" 4K QFHD Matte Display with G-SYNC
- 6GB DDR5 NVIDIA® GeForce™ GTX 970M GPU
- Optional NVIDIA® GeForce™ GTX 980M GPU
- 16GB Dual Channel DDR4-2133MHz Memory
- 250GB Samsung 850 EVO M.2 SSD + 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives or 2 M.2 PCIe SSD Drives capable
- Hardware Raid 0,1 Function capable
- Full sized Keyboard with color LED backlight
- Killer™ DoubleShot™ Pro (Killer E2400 LAN + Killer Dual Band Wireless-AC 1535) with Smart Teaming
- USB 3.1 / Thunderbolt Gen3 Combo Port
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Built-in Onkyo Hi-Fi speakers
- Sound Blaster® X-Fi™ MB5 Sound System

NP8658-S Notebook
$1,899

After $160 Instant Savings

- 6th Generation Intel® Core™ i7-6700HQ Processor (6MB Smart Cache, 2.60GHz)
- Opt. Unlocked Intel® Core™ i7-6820HK Processor
- Windows® 10 Home 64-bit Edition
- 15.6" Full HD IPS Matte Display (1920x1080) with NVIDIA® G-SYNC Technology
- Opt. 15.6" 4K QFHD Matte Display with G-SYNC
- 30 days No Dead Pixel Guaranteed Insurance
- 8GB DDR5 NVIDIA® GeForce™ GTX 980M GPU
- 16GB Dual Channel DDR4-2133MHz Memory
- 250GB Samsung 850 EVO M.2 SSD + 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives or 1 M.2 PCIe SSD Drive capable
- Hardware Raid 0,1 Function capable with SATA Interface
- Full sized Keyboard with white-LED backlight
- Intel® Dual Band Wireless-AC 8260 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Built-in Onkyo speakers
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 1.13 inch thin

NP8678 Notebook
$1,799

FREE UPS GROUND SHIPPING*

- 6th Generation Intel® Core™ i7-6700HQ Processor (6MB Smart Cache, 2.60GHz)
- Opt. Unlocked Intel® Core™ i7-6820HK Processor
- Windows® 10 Home 64-bit Edition
- 17.3" Full HD IPS Matte Display (1920x1080) with NVIDIA® G-SYNC Technology
- 8GB DDR5 NVIDIA® GeForce™ GTX 980M GPU
- 8GB DDR4-2133MHz Memory
- 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives Capable with Raid 0, 1 Function
- Full sized Keyboard with white-LED backlight
- Intel® Dual Band Wireless-AC 8260 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Built-in Onkyo speakers and a subwoofer
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 1.18 inch thin

NP8677-S Notebook
$1,499

After $160 Instant Savings

- 6th Generation Intel® Core™ i7-6700HQ Processor (6MB Smart Cache, 2.60GHz)
- Opt. Unlocked Intel® Core™ i7-6820HK Processor
- Windows® 10 Home 64-bit Edition
- 17.3" Full HD Matte Display (1920x1080) (NVIDIA® G-SYNC Technology optional)
- 30 days No Dead Pixel Guaranteed Insurance
- 3GB DDR5 NVIDIA® GeForce™ GTX 970M GPU
- 16GB Dual Channel DDR4-2133MHz Memory
- 250GB Samsung 850 EVO M.2 SSD + 1TB 7200RPM Hard Drive
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- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 1.18 inch thin

NP8657-S Notebook
$1,399

After $170 Instant Savings

- 6th Generation Intel® Core™ i7-6700HQ Processor (6MB Smart Cache, 2.60GHz)
- Opt. Unlocked Intel® Core™ i7-6820HK Processor
- Windows® 10 Home 64-bit Edition
- 15.6" Full HD Matte Display (1920x1080) (NVIDIA® G-SYNC Technology optional)
- 3GB DDR5 NVIDIA® GeForce™ GTX 970M GPU
- 16GB Dual Channel DDR4-2133MHz Memory
- 120GB Samsung 850 EVO M.2 SSD + 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives Capable with Raid 0,1 Function
- Full sized Keyboard with white-LED backlight
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- Built-in 2.0M FHD Camera & Fingerprint Reader
- Built-in Onkyo speakers
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 0.98 inch thin

NP8640 Notebook
$1,299

After $50 Instant Savings

- 6th Generation Intel® Core™ i7-6700HQ Processor (6MB Smart Cache, 2.60GHz)
- Windows® 10 Home 64-bit Edition
- 14" Full HD IPS Matte Display (1920x1080)
- 3GB DDR5 NVIDIA® GeForce™ GTX 970M GPU with Optimus™ Technology
- 8GB DDR4-2133MHz Memory
- 250GB Samsung 850 EVO M.2 SSD Drive
- 1 Hard Drive + 1 M.2 SSD Drive or M.2 PCIe SSD Drive capable
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- Built-in 2.0M FHD Camera
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 0.99 inch thin

NP7255 Notebook
$999

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- Windows® 10 Home 64-bit Edition
- 15.6" Full HD Matte Display (1920x1080)
- Also available in 17.3" Full HD Matte Display with model NP7270
- 2GB DDR5 NVIDIA® GeForce™ GTX 960M GPU with Optimus™ Technology
- 8GB DDR3-1600MHz Memory
- 1TB 7200RPM Hard Drive
- 8X DVD±R/RW/4X +DL Super Multi Drive
- 1 Hard Drive + 1 M.2 SATA SSD Drive or M.2 PCIe SSD Drive capable
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LAB NOTES

JARRED WALTON **SENIOR EDITOR**

Retailers: Pick Up the Tokens

NFC and chipped cards protect both buyers and sellers

AS MUCH AS I LOVE tinkering, building PCs or even doing some gaming, I do have to venture outside and buy things from time to time. You know, like food. And toilet paper.

When I pay for necessities, there's a good chance I'm going to be swiping my card, which shouldn't be happening at this point.

Ever since the Target hack, chipped payment cards have been taken seriously in the United States. Well, by some people anyway. As of October 1, 2015, whoever is least compliant with the chipped card system known as EMV is the responsible party whenever fraud occurs. On top of that, Apple Pay and now Android Pay are widely available to most people who have NFC-enabled phones.

These technologies make use of tokenization, which is a little confusing at first. Tokenization gives the retailer's machine a one-time use token that's sent to the card issuer. The card issuer checks the token to make sure that it matches up to a card number, and authorizes the card. It then sends a response back to the retailer. After that, the token is kept as a record, and can't be used more than once. It's similar to a nonce that's used for web login sessions.

With tokens, the retailer doesn't ever see the card number in the transaction. Even with chip-and-signature (as opposed to chip-and-PIN used in the EU), tokenization protects both you and the retailer against electronic theft.

NAVY FEDERAL
Credit Union
NAVY FEDERAL
Business Services
NAVY FEDERAL
Credit Union
Business Check C
AAA

Android Pay (NFC) and chipped cards still aren't accepted at all major retailers.

Yet many, many major retailers aren't using chips or NFC. In the worst cases, the retailer has the hardware but it "doesn't work" at checkout, because the company is busy dragging its butt. (I'm looking at you, national drugstore chain in my neighborhood.) Despite what people may think about paying with their phones, using a chipped card is the bare minimum that should be required when using plastic. I'm going to be very disappointed if I'm still swiping a card come summer 2016.

JIMMY THANG

Online Managing Editor

If you know me, you know I'm a Valve fanboy who loves pretty much everything the company has produced. However, it has now ventured into the hardware business, so my love may be in jeopardy. After testing out Valve's new hardware, I'm beginning to see the company's weaknesses. It is simply too small for its own good. When Valve revealed that its Steam Controller would use the top-rated community-made presets for every game by default, I thought that was fantastic, but after testing it out in its early stages, it feels sloppy and lazy. A lot of Valve's own games don't even have great presets, and it seems as though the company might be trying to get the community to do its dirty work.

ZAK STOREY

Staff Writer

This month I've dropped a horrendous amount of time on keyboards and mechanical switches. So much so that I'm almost peripheraled-out. But the struggle to find the perfect mouse mat is piquing my interest. Yes, I still refuse to call it a "gaming surface."

I'm looking for a simple, square(ish), black aluminum mouse mat to rest my lovely DPI-munching precision instrument of death on. After much searching, I've settled on the In Win Batmat. Yes, it's genuinely called that. It's sleek, simple, with a dash of silver accents, and a satin black aluminum top, all for under $40. Am I satisfied? We'll see how it performs, but if it acts like it looks, I'll be a happy man.

Editors' Picks:
Preparing and Repairing

Alan Dexter, executive editor, and Jarred Walton, senior editor, highlight how they've been cleaning up

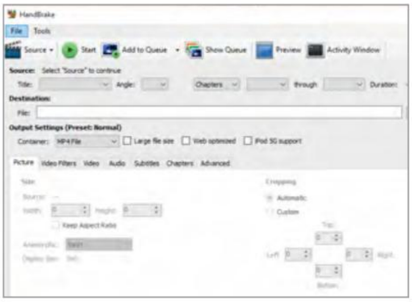
HANDBRAKE

There's never enough time—especially as we head into winter and those little jobs around the house get more pressing. Which is why I've finally decided to tackle the virtual pile of video clips that I've been promising to whip into shape. Hey, the house will mostly still be there come spring, and besides, we need a good collection of home videos to make it through the dark nights. Who needs working guttering?

Problem is, the clips I've gathered over the years come from a variety of sources, and adhere to a myriad standards. Some of them are archaic, and many don't use proper standards at all. Suffice to say, not everything will import into my video editor—though at least VLC can play them back.

I dodge my way through various questionable sites that promise to solve my video incompatibilities—while reducing the performance of my PC, and potentially emptying my bank balance. And then I remember a tool I know does everything I need, and won't cripple my PC: Handbrake. Sure enough, a quick spin through all the clips, and I'm sorted. Obviously, I haven't turned them into an actual video yet, but you can't rush such things... winter's coming.

$ Free, www.handbrake.fr



Source: Select "Source" to continue

Output Settings (Preset: Normal)

Container: MP4 File

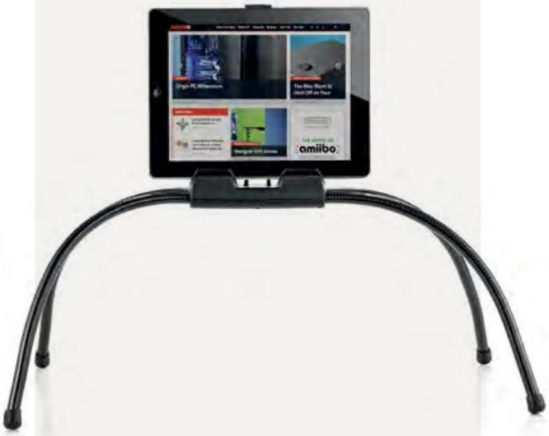
NEATO VS. ROOMBA

There's something wonderfully comforting about waking up in the morning to freshly vacuumed carpets. With three kids, cleaning the floors is a constant battle, so we invested in a robot vacuum. It was absolutely worth the price of admission, and in fact, we now have two, one from Neato and one from Roomba. So, which is better?

The Roomba tends to be more like a vacuuming ping pong ball, bouncing around the rooms in a haphazard fashion, and it frequently misses a few areas. The Neato Botvac Connected, in contrast, maps out the floor plan with a laser eye and systematically covers every spot it can reach. It generally starts with the perimeter of each room, before doing a back-and-forth pattern that leaves nice parallel lines on the carpet. Professional carpet cleaners use a carpet rake after cleaning for the same reason.

The Botvac Connected has extra features like Wi-Fi connectivity, and notifications that aren't critical, and we still have our upright vacuum that sees occasional use, but the Botvac is highly convenient. It's also a good incentive to pick up all the toys every night so "Sweetie Pie" can do his job properly—my wife gave it the name, as "anyone that will vacuum the floors for me is a sweetie pie!"

GEEK TESTED & NOT APPROVED



Tablift

DO YOU EVER FIND yourself reading from your tablet in bed, and becoming annoyed by the fact that you have to hold it? There's a solution for that! It's called the Tablift, and it allows you to use your tablet hands-free.

What's the catch? Well, the Tablift is pretty weird... and a little creepy. The device looks like a black four-legged spider that you place over yourself in bed. The chassis is constructed of a combination of metal and plastic. The four legs feel sturdy, yet bendable at the same time. Atop the center of the Tablift are three horizontal slots where you can put your tablet or phone, each providing a different viewing angle. There's also an elastic band that can further secure your device, in case you're worried about it toppling over.

The Tablift's bizarreness stretches to the price tag, too: $40 feels pretty steep. It's also a hassle to set up and stow away once you're all cozy in bed. It's a device meant for lazy people, but we often found ourselves too lazy to use it. Unless you've got wrist issues, you can pass on the Tablift **–JT**

$40, www.tablift.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Mobo Storage Choices
> Intel vs. AMD
> Boot Menu

Too Many Choices

Help! I am concerned about owning an Intel i7-5960X (LGA 2011-v3).

I was ready to invest in LaCie Thunderbolt storage for my Asus X99-E WS, when HDDs sort of disappeared off the face of the earth. So, I instead used the downtime to read up on USB 3.1, PCIe M.2, and Thunderbolt. Well, I learned in your August issue about a possible clash between PCIe-based SSDs and performance graphic cards, which made me question my Samsung M.2 card. And I found an article at MaximumPC.com, "Gigabyte Z170X-UD5 TH Mobo with Thunderbolt 3" (and USB3.1), which got me excited about upgrading, until I verified that it only supports LGA 1151 (Skylake) and not LGA 2011-v3.

Have you heard anything about LGA 2011-v3 mobos that will support/offer TB3 and USB3.1? Or is it best to jump ship now and join the Skylake revolution?

—Jerry Franco, Jr.

SENIOR EDITOR JARRED WALTON RESPONDS: Hi, Jerry. Since you have an i7-5960X, congrats: You already own the fastest CPU we're likely to see until sometime in late 2016. If you were thinking about buying into X99 and an i7-5960X right now, things would be more complicated.

For max performance from an SSD, you want a PCIe Gen3 x4 connection—this is mostly a concern if you're getting an M.2 SSD, as many X99 boards only use PCIe Gen2 x2. If you get a PCIe add-in board with an SSD, like the Intel SSD 750, you also have the issue of using one of your PCIe slots for SSD storage. That may not be an option for people planning to go all-in on graphics performance and run three or four GPUs, but we generally don't recommend such configurations, due to diminishing returns.

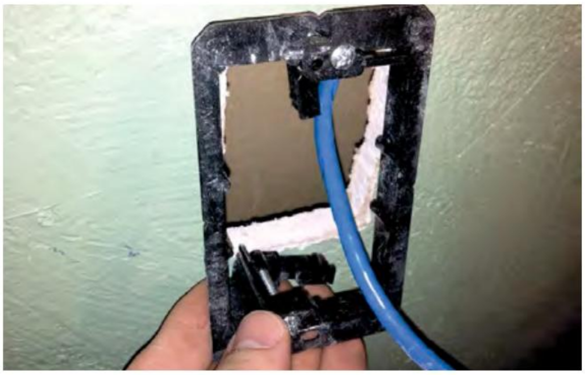
For maximum M.2 SSD performance, Z170 is a safer bet than X99, and you're also much more likely to find Thunderbolt 3 and USB 3.1 support. Will we see some X99 boards with TB3? It's possible at some point, but right now the only TB3 mobo is the Gigabyte Z170 you mention. Keep an eye on the Thunderbolt website (http://bit.ly/MPC_tbproducts) to find out about new TB3 products. But even if we start seeing TB3 with X99, we run into some of the same issues as M.2 on X99: Some boards may not deliver maximum throughput on the older chipset. If you're paying top dollar for hardware, you probably want the maximum performance possible.

Having used X99 and Z170 with a variety of GPUs, SSDs, and software, I can honestly say that most of the differences for end-users are academic. If I'm doing video encoding or another task that can leverage all six or eight cores of a Haswell-E processor,

[NOW ONLINE]

HOW TO: FUTURE-PROOF YOUR HOME NETWORK

Wi-Fi has come a long way and is undeniably fantastic, especially with the advent of speedy 5GHz 802.11ac. Still, nothing beats the throughput of a wired 10 gigabit Ethernet connection. We realize that, most likely, not every room in your home has Ethernet access, but we can help you change that. In our in-depth guide online, we show you all the tools, tips, and tricks you need to get your house wired from top to bottom. Ready to get down and dirty? Check out the how-to guide online. http://bit.ly/MPC_ethernet



Wired Ethernet knocks Wi-Fi into a cocked hat.

↘ submit your questions to: comments@maximumpc.com

X99 wins; for gaming and most other tasks, everything from Core i5 Ivy Bridge through Core i7 Skylake tends to feel similarly fast. If you're looking to upgrade today and will use a TB3 peripheral, Skylake and Z170 is the only choice, and it's a good one. If you can wait, in mid- to late-2016 we're likely to get Skylake-E on an updated platform, which will make the current Haswell-E/X99 platform look long in the tooth.

AMD FTW!

I'm sorry but Skylake comes in a really pretty box and it seems like the same thing as AMD processors. The difference is insignificant. **—J**

SENIOR EDITOR JARRED WALTON RESPONDS: Hi, J. I get what you're saying—and I even tested Skylake against Bloomfield (http://bit.ly/MPC_skbf) to see what sort of real-world performance differences we could find. Depending on what you're doing, Skylake is as much as 50 percent faster than my old, overclocked Bloomfield chip, but in other cases, particularly gaming, it's often an insignificant upgrade. Realistically, if you're running a high-end GPU with a 1440p or UltraHD display, you will often be limited by the GPU rather than the CPU. So if that's your only criterion for upgrading, your money is better spent elsewhere.

That doesn't make Skylake bad or "insignificant," and in certain workloads Skylake is up to 20 percent faster than Haswell—overclocked, it can easily double the performance of an old Bloomfield system. Skylake also offers far more flexibility, thanks to the new Z170 chipset and DMI 3.0 link, which will be increasingly important for things like USB 3.1, Thunderbolt 3, M.2 NVMe SSDs, etc.

As far as AMD goes, it has ceded the high-performance crown to Intel for now, with its upcoming Zen processor being the first real chance for it to compete since Intel released the Core 2 Duo in 2006. Since then, AMD has competed almost exclusively on price, and it has had plenty of decent processors (APUs in particular). We've used and recommended them, and at the lower price points, they're still worth a look.

But if you're going to spend money on a new system, it's hard to be interested in building something with old technology. We don't recommend people go out and build new Sandy Bridge or Ivy Bridge systems, even though you could—or buy a good used system for a song. It's now four years since the Zembezi architecture launched (eg, FX-8150) and three years since Vishera (FX-8350). If you buy either of those and your system still works well, that's great. When it eventually breaks down or gets too slow, technology enthusiasts will inevitably look to the latest and greatest processors.

New Route to Boot

I got a call from a friend asking for help with a locked-up Windows 8.1 laptop. I told her all the ways to launch the Boot menu, but none worked. So I tried to get into the Boot menu on my Windows 10 laptop and couldn't. Eventually, via a Google search, I learned that if you want to get from a cold boot into the Boot menu in Windows 8 or 10, you use the shift key at the login screen along with the restart key. The article I read said the OS loads so fast that there is no time to check key strokes.

Because this was such a pain to find, I thought I'd drop you a line. I might not be the only one who thought you could F8 into the Boot menu like in the old days. **—Herm**

SENIOR EDITOR JARRED WALTON RESPONDS: Hi, Herm. You're correct, and we probably haven't mentioned this lately, so now is as good a time as any.

Windows 8.1 and 10, particularly when using UEFI, have made accessing the advanced startup options (or the BIOS) more difficult, especially on laptops. Because boot times are often a differentiating factor, there's usually no way to get into the BIOS or advanced startup options on modern laptops, without going through Windows.

Your shortcut of pressing Shift while hitting restart is one option, or you can just type "startup" in the Start menu/screen and choose "Advanced startup." Along with making it harder to get into the BIOS, Windows 8 and later have basically killed the F8 menu. Which is, of course, a problem if you ever have a system that can't fully boot into Windows. In theory, it still works, but if you have a UEFI system with an SSD, you're out of luck. In that case, if you can't get into Windows to access the advanced startup options, you'll have to use a recovery disc (or recovery USB stick if you prefer).

Facebook Polls

What future technology are you most looking forward to?

Richard Schmidt: Fusion power. Although I doubt energy will get any cheaper when it's practical (utility monopolies and all that).

Ryan Clark: Nano technology. I really believe it to be the holy grail of curing disease and extending lifespans. There is almost no limit to how we can design nano technology to interact with the body and detrimental organisms that live inside the body.

Jarred Walton: I am totally looking forward to fully automated cars—having read plenty of Asimov and Heinlein in my youth, I can't wait to let the carputer do the dirty work of driving!

Chris Kerschen: DirectX 12.

Eugene Satorre: A Jarvis-like AI interface.

Craig Etheredge: Jump portals.

Alex Acosta: SAO technology.

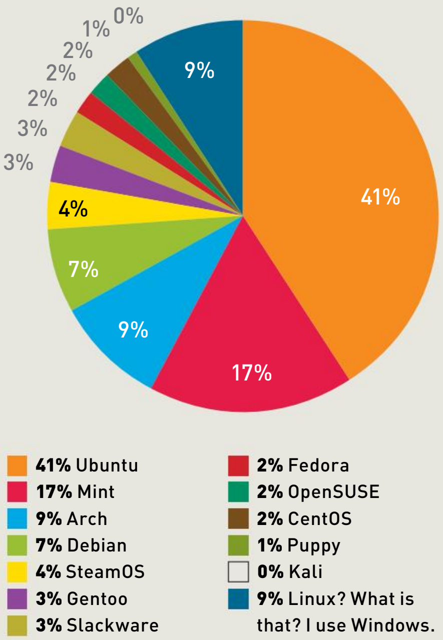
Steve Lawnick: Holodeck.

Frosty Winnipeg: Paperless society.

Lars Richard: AMD's Zen CPUs.

Malcolm Reynolds: VR Waifus with simulated responses and haptic feedback.

What is your Linux distro of choice?



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THE BUILDS

BUDGET GAMER

INGREDIENTS

PART			PRICE
Case	Cooler Master Elite 110		$40
PSU	Corsair CS450M 450W/80 Plus Gold	**NEW**	$60
Mobo	ASRock H170M-ITX/ac		$100
CPU	Intel Core i5-6400		$190
GPU	EVGA 1962-KR GeForce GTX 960 SC	**NEW**	$220
RAM	G.Skill Ripjaws 4 Series 8GB (2x 4GB) DDR4 2133 (Red)	**NEW**	$50
SSD	500GB Samsung 850 EVO	**NEW**	$167
OS	Ubuntu Desktop Linux 14.04 LTS 64-bit		$16

Approximate Price: $843

THE PC PARTS GOD SMILED upon us, and we were able to keep the price of this rig level with last month's $843. Price creep meant we had to rethink some parts, though. First, there was a significant increase in price for the 550W EVA PSU. But what do we need 550 watts for? We found that 450W would do just fine. We went with a fully modular Corsair model, which will help alleviate headaches when assembling a rig in such a tiny box. The PSU is still 80 Plus Gold certified—the only downside is the three-year warranty as opposed to EVGA's five. We also went with a slightly weaker version of the GTX 960. This EVGA model is the same size as we used last month, but the factory OC is a little more conservative. Every dollar matters at this price point, so if you want to push your clocks, do it in software. As for storage, the price of the MX200 jumped up, but the 500GB Samsung 850 Evo was priced lower than the MX200, so we went with trusty old Samsung.

MIDRANGE

INGREDIENTS

PART			PRICE
Case	Corsair Carbide 500R		$110
PSU	EVGA SuperNOVA G2 650W	**NEW**	$100
Mobo	Gigabyte Z170X-Gaming 3		$150
CPU	Intel Core i5-6600K		$270
Cooler	Corsair H100i		$120
GPU	MSI R9 390	**NEW**	$330
RAM	Kingston HyperX Fury 8GB (2x 4GB) DDR4 2133	**NEW**	$54
SSD	500GB Samsung 850 EVO M.2		$178
HDD	Western Digital Black Series 1TB		$70
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $1,482

SOMEHOW WE GOT THIS BUILD below last month's total of $1,490. Major components, such as the mobo, case, and CPU, tend to change very little (although the Core i5-6600K went up $10). It's the GPUs, memory, and storage we have to keep our eyes on. We weren't surprised to see a $40 rise for the Asus R9 390 Strix. However, with more vendors bringing R9 300-series offerings into the mix, we had quite a choice. We went with MSI's implementation, which uses the Twin Frozr cooling design. It only cost $10 more than last month. For memory, we went with Kingston's HyperX Fury sticks. We had these in our budget build last month, but we found a G.Skill kit cheaper. With a little more wiggle room in the midrange, we opted for the HyperX sticks because of the modules' better timings. We were able to save a bit by dropping to a 650W PSU. Even with the R9 390's appetite for power, the 650W still gives around 200W of headroom for some overclocking play.

TURBO

AFTER BUILDING an SLI-enabled rig with a pair of GTX 980 Tis last month at just $1 over our $3,000 budget mark, we were pretty happy with ourselves. As a result, we found it hard to improve on that build. But prices change. One of the things that changed was the cost of the EVGA reference 980 Tis. However, after a bit of shopping, we found Zotac offering 980 Tis for $630 apiece. That's a saving of about $40 for the pair. Not bad at all. Unfortunately, price increases for the cooler and PSU chipped away at those savings. On the bright side, we found some inexpensive DDR4 RAM modules from G.Skill. At $100, this 16GB kit is plenty for our purposes. We were eyeing a kit of HyperX Predators for their better timings, but Kingston's offering was $44 more. That put us too close for comfort to our budget limit. We stayed with the 2.5-inch SATA 850 EVO as well, because the 1TB model still gives us reason to salivate. 1TB is plenty for most uses, and with the 1TB WD Black for backup, the two drives make for a nice, robust system. Now, if only the prices for the 950 Pro would come down....

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART		PRICE
Case	Corsair Graphite 780T	$190
PSU	EVGA SuperNOVA G2 850W	$150
Mobo	Asus X99-A/USB 3.1	$250
CPU	Intel Core i7-5820K	$390
Cooler	Corsair H100i GTX Extreme	$120
GPU	2x Zotac GTX 980Ti (Reference) **NEW**	$1,260
RAM	16GB (4x 4GB) G.Skill Ripjaws V Series DDR4 2133 **NEW**	$100
SSD	1TB Samsung 850 EVO	$346
HDD	1TB WD Black	$70
OS	Windows 8.1 64-bit OEM	$100

Approximate Price: $2,976

UPGRADE OF THE MONTH

500GB SAMSUNG 950 PRO

V-NAND SSD
950 PRO M.2
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SAMSUNG
nvm EXPRESS

If there's one thing to drool over, it's Samsung's new SSD, the 950 Pro. This NVMe SSD offers a blistering 2,500MB/s read speed, which is rivaled only by Samsung's SM950 (a server SSD) and Intel's 750.

The cost for speed is high, though: For the price of this 500GB SSD, you can get a 1TB 850 Evo. Choices, choices.

$348, www.samsung.com

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